TRANSISTOR SPECIALTIES
AN/USM-245A
1 OF 2

NAVSHIPS 0969-244-6010

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CALIBRATION LAB

TYPE II

TECHNICAL MANUAL

for

COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-245A

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DEPARTMENT OF THE NAVY
BUREAU OF SHIPS

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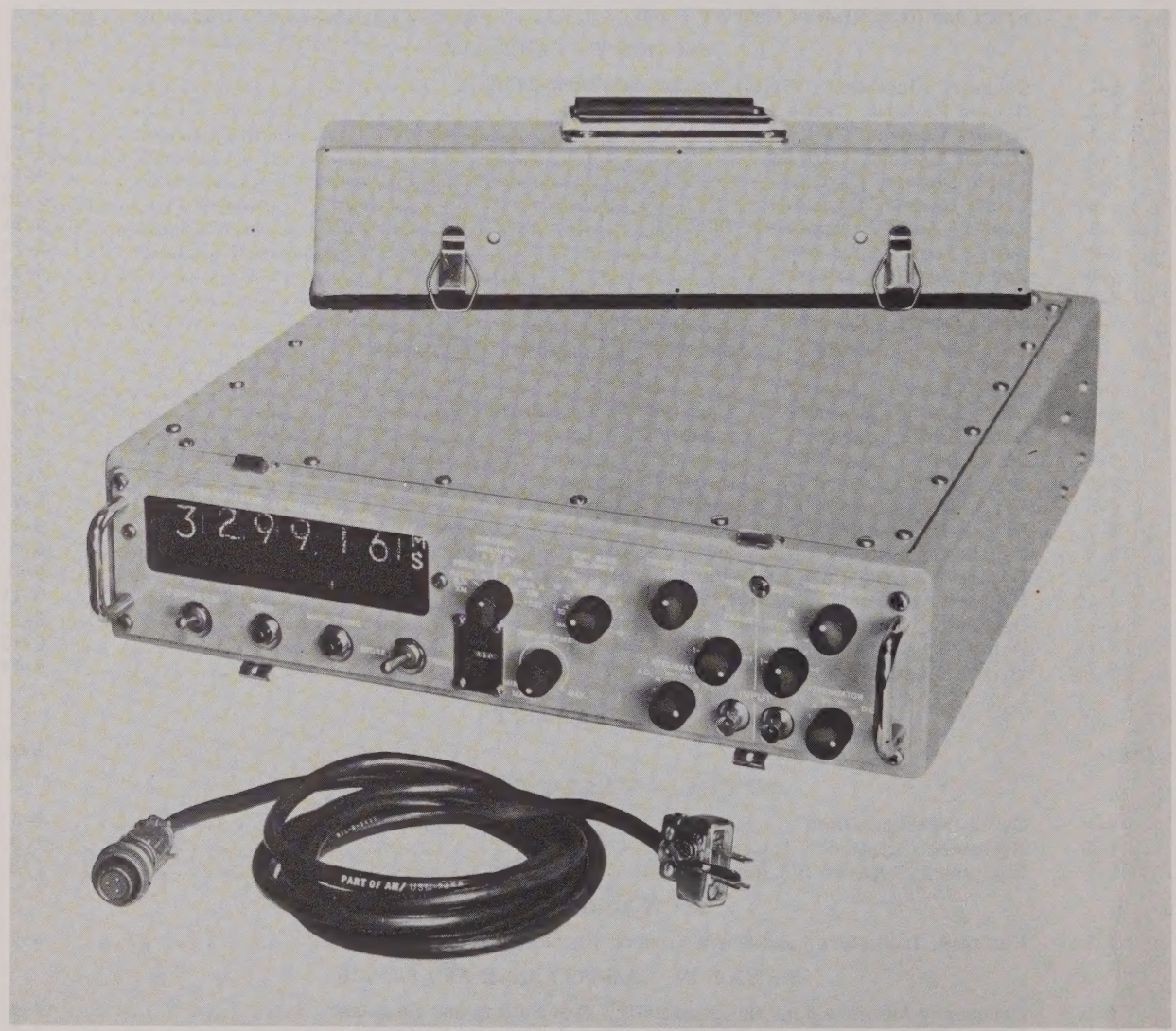


Figure 1-1. Counter, Electronic, Digital Readout AN/USM-245A

SECTION I

GENERAL INFORMATION

1-1. PURPOSE OF EQUIPMENT.

1-2. The Counter, Electronic, Digital Readout AN/USM-245A is designed and manufactured by Transistor Specialties Incorporated, a division of Darcy Industries Inc., 120 Terminal Drive, Plainview, N.Y. 11803, under Contract No. N00024-67-C-1288. The Counter, Electronic, Digital Readout AN/USM-245A (herein after referred to as the Counter) provides direct reading indication of the frequency and period of a cyclic electronic signal, the frequency ratio, and the time interval between two electronic signals, and the total number of electronic impulses. The frequency and time interval indications are displayed on six in-line digital display Nixie tubes visible on the front panel of the Counter. In addition, decimal point indicators are provided between the appropriate frequency and time indicator display digits for indicating the correct division of the frequency of time indications. A character tube displays the measurement units.

1-3. DESCRIPTION.

1-4. PHYSICAL. The design of the Counter is based upon modular construction and makes maximum use of replaceable, repairable plug-in assemblies. All electronic components which constitute the Counter are contained in an aluminum drip-proof case suitable for mounting into a standard 19-inch rack. With the exception of certain components (e.g., power supply transformer, oscillator oven transformer, controls, switches, indicators, wiring, and connectors) all circuits are solid-state and are contained on removable printed circuit cards. A removable top cover facilitates access to the internal components. All controls necessary for normal operation of the Counter are located on the front panel. Two channel input connectors are also provided on the front panel. Additional input and output connectors are provided on the rear panel.

1-5. FUNCTIONAL. Figure 1-2 is a simplified block diagram of the Counter electronics and illustrates signal flow between printed circuit cards. A 1 MHz crystal oscillator provides the fundamental time base frequency for the Counter. The 1 MHz signal is amplified in card A12 and is frequency divided in succeeding stages to provide counting intervals as determined by the position of the TIME BASE SECONDS switch. In the test mode of operation, the Counter counts the internal 1 MHz signal for gate times of 1 usec. to 10 sec. in decade steps. In addition, all standard frequency outputs available at connector J18, all standard counting frequencies, and all gate times are derived from the 1 MHz frequency source. This source is at the option of the operator, either the internal oscillator or an external frequency standard, depending upon the position of switch S12.

1-6. The frequency divider consists of two triple decade cards (A7 and A8) and single decade card (A13). Each triple decade card contains three conventional divide-by-ten flip-flop counters. An additional flip-flop counter is provided on card A13. The frequency divider divides the fundamental 1 MHz frequency into seven frequencies: 1-10-100 KHz, 1-10-100 Hz, and 0.1 Hz. The seven frequencies are applied to TIME BASE SECONDS switch.

1-7. Input signals are applied to the Counter via connectors J12 and J13. ATTENUATOR switches S9 and S11 permit the proper selection of attenuation for the input signals by providing attenuation factors of 1, 10 and 100 for both ac and dc signals. Amplifier card A9 provides waveshaping and amplification of the input signal and contains two identical channels. Each channel contains trigger level controls which permit triggering of each channel to be independently adjustable. Similarly, slope selection controls are provided to permit triggering of each channel to be selected independently on either the positive or negative slope of the incoming signal. During time interval measurements, both inputs may be connected together for obtaining both start and stop signals from a common line. This is accomplished by placing SEP./COM. switch S13 to the COM. position.

1-8. The Counter mode of operation is established by the position of FUNCTION switch S6. Depending upon the position of switch S6, the Counter will measure and indicate the frequency of electrical signals; the period of electrical signals for a single period or the average over multiple periods; the ratio of the frequencies of two signals; the time interval between signals. In addition, the Counter may be used to indicate the total number of input signal events occurring over any period of time. Scaling is also provided. Each operating mode is described in detail in Section III of this manual.

1-9. Gating logic card A10 provides the counter trigger frequency, reset and storage output to the decade readout cards. Decade readout cards A1 through A6 each count up to nine then overflow into the next decade. Thus, the total count from the six cards can be 999,999.

1-10. QUICK REFERENCE DATA.

1-11. Pertinent technical and design characteristics for the Counter are listed in table 1-1.

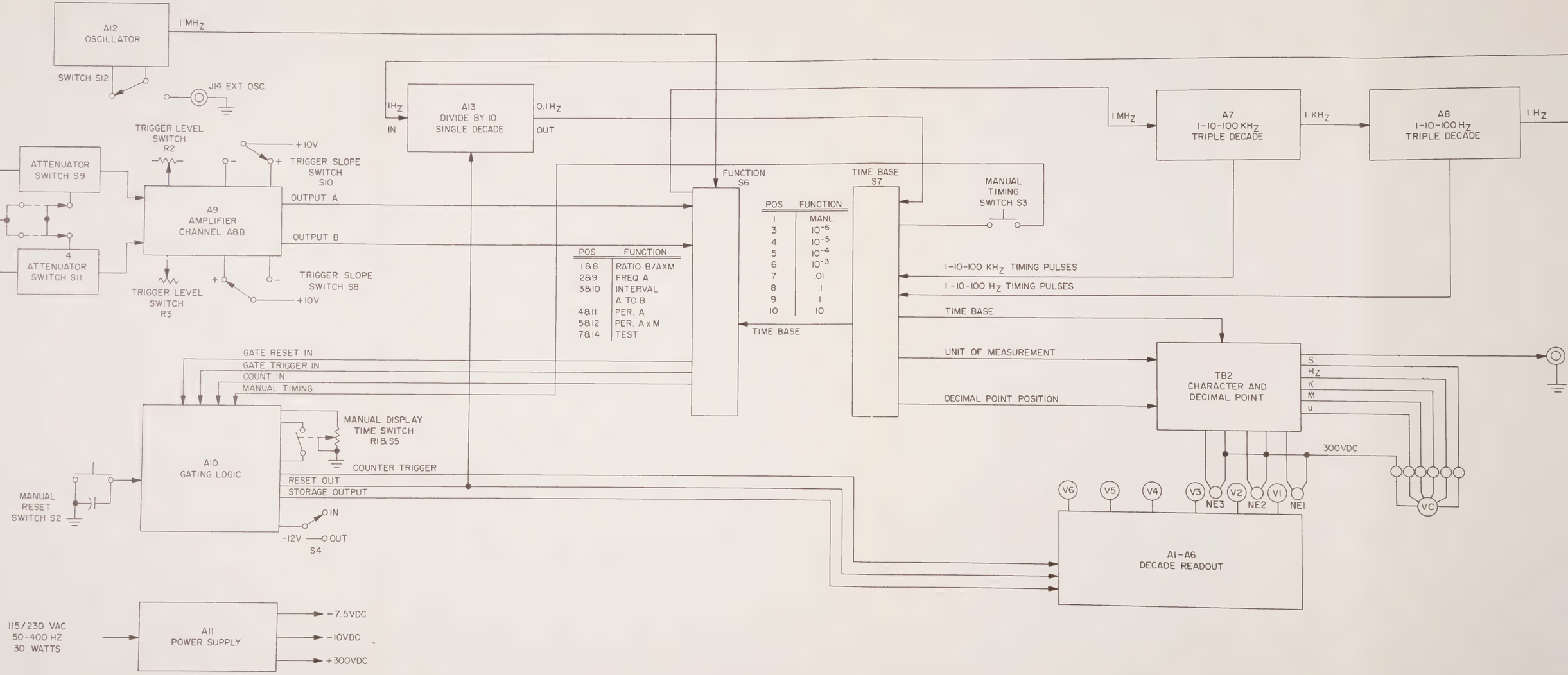


Figure 1-2. Functional Block Diagram

1-12. EQUIPMENT SUPPLIED.

1-13. Table 1-2 lists all equipment supplied.

1-14. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

1-15. Table 1-3 lists the equipment required to troubleshoot and maintain the Counter. The non-specialized tools and test equipment are not supplied. Although some test and troubleshooting equipment is referred to by manufacturer's name and number, their indicated range characteristics can be used to obtain satisfactory equivalents.

TABLE 1-1. QUICK REFERENCE DATA

CHARACTERISTIC	SPECIFICATION
Nomenclature	Counter, Electronic, Digital Readout AN/USM-245A
Function(s)	The Counter provides the following functions: a. Frequency measurements b. Period and multiple period measurements c. Frequency and multiple ratio measurements d. Totalizing e. Scaling f. Time interval measurements g. Self-test
Overall size	16-1/2 inches wide by 4-7/8 inches high by 21-1/6 inches deep
Weight	25 pounds
Frequency measurements	INPUT CHANNEL: A RANGE: dc to 2.5 MHz ACCURACY: 1 count time base stability UNITS DISPLAYED: Hz, KHz, MHz GATE TIMES: 1 usec. to 10 sec. in decade steps
Period and Multiple Period Measurements	INPUT CHANNEL: A RANGE: dc to 100 KHz in single period, dc to 1 MHz in multiple period ACCURACY: ±1 count ± time base stability, $\pm \frac{\text{trigger error*}}{\text{periods averaged}}$ UNITS DISPLAYED: Single period, S, MS, uS, with automatic decimal point. Multiple period, uS with automatic decimal point for single period, 10^3 x single period, 10^6 x single period TIME BASE COUNTED: 1 usec. to 10 sec. in single period. 1 usec. in multiple period PERIODS AVERAGED: 1 to 10^7 in decade steps

*Trigger error is defined as 0.3 percent for a sine wave of 40db signal to noise ratio and 100 mv rms amplitude. Error decreases with higher amplitudes and sharper rise times than that of a sine wave.

TABLE 1-1. QUICK REFERENCE DATA (CONT)

CHARACTERISTIC	SPECIFICATION
Frequency Ratio and Multiple Ratio Measurements	RANGE: Channel A: dc to 1 MHz Channel B: dc to 2.5 MHz MEASURES: B/A XM ACCURACY: ±1 count of B $\pm\frac{\text{trigger error of A}}{\text{multiplier}}$ MULTIPLIER: 1 to 10^7 in decade steps
Totalizing	INPUT CHANNEL: A MAXIMUM COUNTING RATE: 2.5 MHz MAXIMUM COUNT DISPLAYED: 999,999 START AND STOP CONTROLS: Manual time base pushbutton
Scaling	RANGE: 1 MHz INPUT CHANNEL: A FACTOR: 1 to 10^7 FUNCTION SETTING: Manual time base pushbutton
Time Interval Measurements	INPUT CHANNELS: A, B TIME RANGE: 10 sec. to 10^7 sec. MEASURES: A to B ACCURACY: ±1 count ± time base stability ± trigger error of A and B* UNITS DISPLAYED: uS, MS, S with automatically positioned decimal point TIME BASE COUNTED IN DECADES: 1 usec. to 10 sec. EXTERNAL CLOCK ACCEPTED: 1 MHz
Time Base	FREQUENCY: 1 MHz STABILITY: Aging: ±3 parts in 10^7/wk Short Term: ±1 part in 10^7 per 100 sec., ±2 parts in 10^7 peak-to-peak deviation over a 1000 second period with 10 seconds averaging. Temperature: ±5 parts in 10^7 from 0°C to +50°C Warm-up: ±2 parts in 10^7/1000 sec. after 2 hours. ±2 parts in 10^6/wk after 48 hours EXTERNAL TIME BASE INPUT: Frequency: 1 MHz Sensitivity: 1 volt rms Impedance: 1000 ohms shunted by 50 pf Maximum input without damage:: 600v dc OUTPUT RANGES: 1 MHz to 0.1 Hz decade steps Amplitude: 1.5v peak-to-peak Impedance: 600-ohm source Wave shape: negative pulse train 80/20 duty cycle

*Trigger error is defined as 0.3 percent for a sine wave of 40 db signal to noise ratio and 100mv rms amplitude. Error decreases with higher amplitudes and sharper rise times than that of a sine wave.

TABLE 1-1. QUICK REFERENCE DATA (CONT)

CHARACTERISTIC	SPECIFICATION
Inputs	CHANNELS: A, B Range: 10 Hz to 2.5 MHz, ac coupled 0 to 2.5 MHz, dc coupled Sensitivity: Sine: 100 mv rms Pulse: 280 mv peak-to-peak INPUT IMPEDANCE: 1 megohm shunted by 80 pf ATTENUATION FACTORS: 1, 10, 100 TRIGGER LEVEL CONTROLS: ±1V x attenuation factor SLOPE CONTROL: positive and negative included
Self-Test	Counts internal 1 MHz signal for gate times of 1 uS to 10 sec. in decade steps
General	REGISTRATION: 6 digits in line Nixie readout UNIT INDICATOR: Units of MHz, KHz, Hz, uS, MS, S displayed in Nixie tube in line with digital display. Decimal point automatically positioned DISPLAY STORAGE: Display is held and up-dated after each measurement. A front panel switch disables storage function. TEMPERATURE RANGE: Operating: 0°C to +50°C Storage: -65°C to +75°C POWER REQUIREMENTS: 115/230 volts ac ±10 percent, 50-400 Hz, 30 watts

TABLE 1-2. EQUIPMENT SUPPLIED

NOMENCLATURE	TYPE	QTY
Counter, Electronic, Digital Readout	AN/USM-245A	1
Power Cable	Type A	
Extender	TSI Part No. 644-A-123	1
Cable Assembly, Radio Frequency	CG-409G/U	1
	BNC (UG-88E/U)	2
Adapters:		
BNC male to UHF female	UG-255/U	1
BNC female to UHF male	UG-273/U	1
BNC male to binding post	UG-1035/U or UG-1441/U	1
BNC Tee	UG-274/U	1
Technical Manual	Type II	1

TABLE 1-3. EQUIPMENT REQUIRED BUT NOT SUPPLIED

ITEM	FUNCTION
Voltmeter AN/PSM-4, Simpson Voltmeter Type 260 or equal: DC Voltmeter, 20,000 ohms per volt, with scales 0 to 10 volts DC and 0 to 300 or 500 volts DC.	Maintenance
Signal Generator Hewlett-Packard Model 650A or equal: Sine wave of 10 Hz to 2 MHz at 100 mv rms.	Maintenance
Tektronix Oscilloscope Type 531 with CA Plug-in or equal	Maintenance
Tuning screwdriver, plastic with metal tip, JFD tool No. 5284 or equal	Maintenance
Coaxial cables, various lengths	Maintenance
L. F. VTVM High Frequency Counter Hewlett-Packard Model 400H AN/USM-207 appropriate printer	Maintenance
Audio Oscillator Power amplifier General Radio GR-1308A	Maintenance
Autotransformers General Radio Model W30H-240V	Maintenance
Function generator Hewlett-Packard Model HP202A	Maintenance

SECTION II

INSTALLATION

2-1. UNPACKING.

2-2. The Counter has been inspected and tested before shipment. Only minor preparations are required before installation and inspection. The Counter is packed in a cardboard box, which measures 8 inches high by 23 inches long by 23 inches deep. The shipping weight is 30 pounds. To unpack proceed as follows:

a. Carefully open the cardboard box and remove the sealed bag containing the Counter.
b. Open the sealed bag and remove the inner wrap-around protector box.
c. Remove the wrap-around box and the desiccant. Open the envelope containing the operating instructions for the Counter. Unwrap the accessory items.
d. Since there is a possibility of repacking the Counter it is suggested that the packing materials be saved.

2-3. INSPECTION.

2-4. After unpacking the Counter, carefully inspect for visible damage. Remove the top cover and check for parts which may have come loose during shipment.

2-5. INSTALLATION.

2-6. The Counter can be installed in any standard 19-inch rack, or placed on a work bench. When the Counter is placed into position, make sure that the POWER ON switch is in the off position. Plug power cord into a 115-vac power source.

NOTE

Power is applied to the oscillator oven when the POWER ON switch is in the off position. There is no visible indication of this.

2-7. Place the POWER ON switch in the on position. The Nixie tubes shall glow. If it is required to verify that the Counter is operating properly, refer to Section III of this manual. The TEST mode of operation is presented in paragraph 3-6.

2-8. The cable assemblies that are supplied as accessories can be utilized for any of the functions which terminate in the BNC connectors.

SECTION III

OPERATION

3-1. GENERAL.

3-2. This section describes operating instructions for the Counter. The Counter measures frequency, period and multiple period, time interval and the ratio of two frequencies. A self-test function is provided to allow confirmation of proper Counter operation before actual use. The Counter displays its measurements on six in-line Nixie tubes. Direct readout is provided in the frequency, period, multiple period, and interval A to B modes of operation, with measurement units displayed and decimal points automatically positioned. The units of measurement displayed are as follows:

MHz	Megahertz
KHz	Kilohertz
Hz	Hertz
uS	Microseconds
MS	Milliseconds
S	Seconds

3-3. CONTROLS AND INDICATORS.

3-4. The controls and indicators shown in figure 3-1 are listed in table 3-1. The table lists the nomenclature of each control and indicator, describes its function and gives the associated reference designation.

3-5. OPERATING PROCEDURES.

3-6. TEST MODE OF OPERATION. This mode of operation measures frequency, utilizing either the internal 1 MHz oscillator or an external 1 MHz clock. All the Counter circuitry except the A and B amplifier circuits are checked in the TEST mode. The ATTENUATOR switches, TRIGGER SLOPE switches, TRIGGER LEVEL controls are by-passed in this mode. Proceed as follows:

a. Place the POWER ON switch in the on position. The six Nixie tubes shall glow.
b. Verify that the 1 MHz INT. /EXT. switch on the rear panel is in the appropriate position.
c. Place the FUNCTION switch in the TEST position.
d. The STORE/TRACK switch can be left in either position.
e. Rotate the DISPLAY TIME switch to the MIN. position.
f. Select the TIME BASE SECONDS setting indicated below. Readings and decimal points shall be within the limit shown. The readings may deviate by ±1 count of the least significant digit.

TIME BASE SECONDS Settings	6 digit readings	Units
10^{-6}	0.00001	MHz
10^{-5}	00001.0	MHz
10^{-4}	0001.00	MHz
10^{-3}	001000.	KHz
.01	01000.0	KHz
.1	1000.00	KHz
1	000.000	KHz
10	00.0000	KHz

3-7. FREQ. A MODE OF OPERATION. This mode of operation measures the frequency of an input to channel A. The procedure is as follows:

a. Place POWER ON switch in the on position. The Nixie tubes shall glow.
b. Place STORE/TRACK switch in the TRACK position.
c. Select a display time. Refer to paragraph 3-18.
d. If necessary for this measurement, make connections on the rear panel. Determine if an external or internal 1 MHz oscillator is to be used and check the position of the 1 MHz INT. /EXT. switch.
e. Set FUNCTION switch to the FREQ. A position.
f. Select a time using TIME BASE SECONDS switch.
g. Set ATTENUATOR control and TRIGGER LEVEL controls to the appropriate position. Connect the input signal to be measured to the A INPUT connector.
h. The Counter will count the input signal which will be displayed for the selected time.

3-8. PER. A MODE OF OPERATION. This mode of operation is used to measure the interval between successive input pulses, or between successive cycles of a periodic waveform. Proceed as follows:

a. Place POWER ON switch in the on position. The Nixie tubes shall glow.
b. Set STORE/TRACK switch to the TRACK position.
c. Make connections on the rear panel BNC connectors, if this measurement requires it. Check to see that the 1 MHz INT. /EXT. switch is in the correct position.

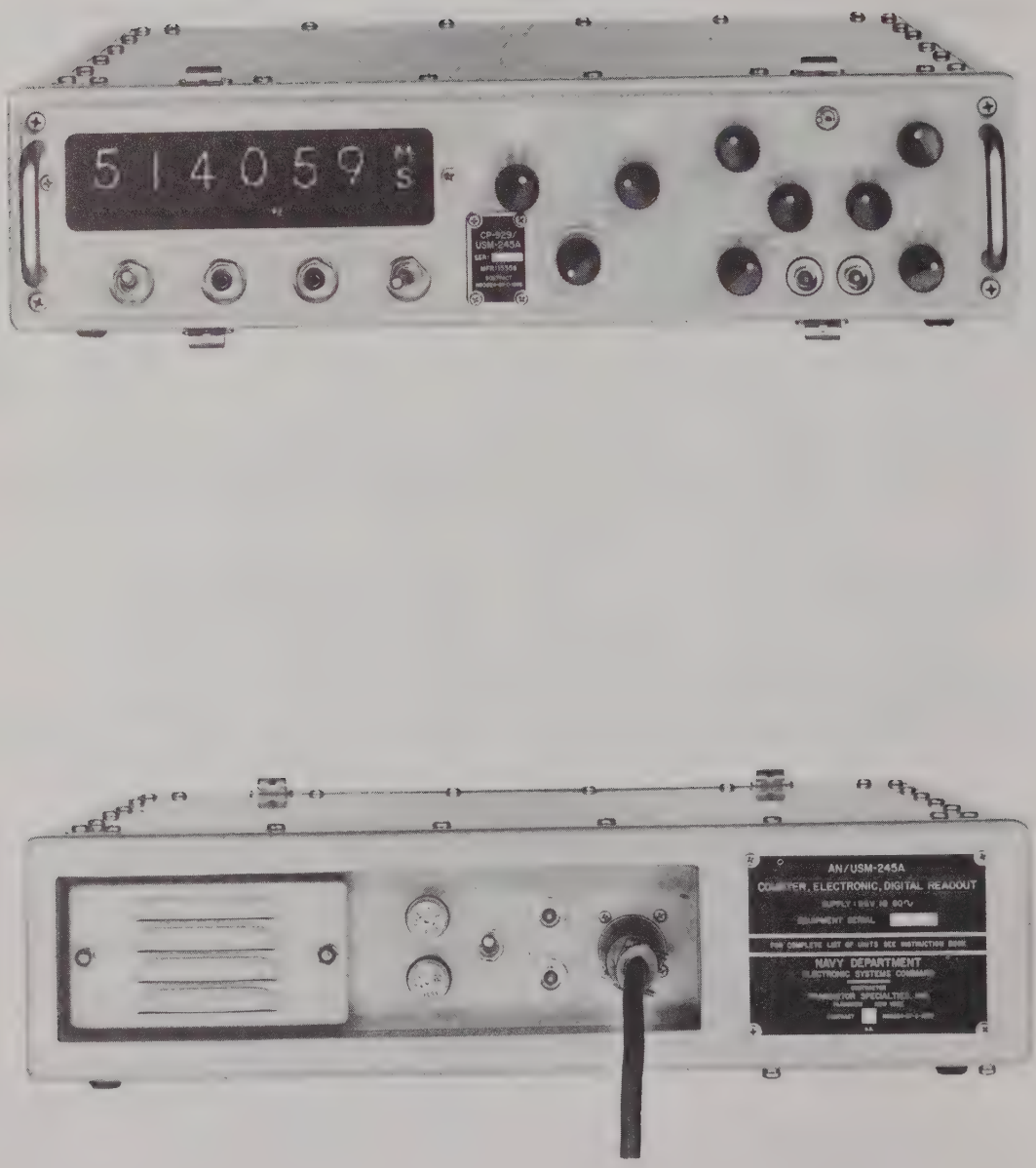


Figure 3-1. Front and Rear View of Counter Panel

TABLE 3-1. CONTROLS, INDICATORS, AND CONNECTIONS ON FRONT AND REAR PANELS

NAME	FUNCTION
FRONT PANEL	
POWER ON toggle switch (S1)	When place in the on position, full operating power is applied to the Counter. When placed in off position, power is removed from the Counter except for the oscillator oven. Power for the oscillator is always available as long as the power cord is plugged into a 115v ac, 60-Hz source.
RESET pushbotton switch (S2)	A snap-action switch. When pressed, all circuits within the Counter are reset. Any display on the Nixie tubes will return to six zeros when this switch is pressed.
MANL. TIMING pushbutton switch (S3)	A snap-action switch. Successive actuations of the switch starts and stops the count gate, when the TIME BASE SECONDS switch is in the MANL. position.
STORE/TRACK toggle switch (S4)	In the STORE position, the display does not change unless the new count differs from the previous, and only the digits that are to be updated are changed. In the TRACK position the count is updated at a 50 KHz rate. Since 50 KHz is faster than the human eye can detect, it appears as if the Nixie tubes are incrementing for each input pulse.
DISPLAY TIME control (S5)	Consists of a potentiometer and a switch. This control varies the time (0.2 to 5 seconds) during which the count is displayed. The switch allows selection of infinite display time in the MANL. position.
FUNCTION rotary switch (S6)	A six position rotary switch used to select the RATIO B/A XM, FREQ. A, INTERVAL A TO B, PER. A, PER A XM. and TEST.
TIME BASE SECONDS rotary switch (S7)	A nine position rotary switch used to select the required time base for a particular measurement. When the TIME BASE SECONDS switch is placed in the MANL. position, timing is controlled manually. The red engravings (0 through 7) indicate the multiples which can be selected for the measurements of RATIO B/A XM and PER A XM. With the TIME BASE SECONDS switch in the MANL. position, and the DISPLAY TIME control in the MANL. position, a new count is initiated by pressing the MANL. TIMING pushbutton switch. The Counter will continue to count until the MANL. TIMING pushbutton switch is pressed again.
TRIGGER SLOPE rotary switches (channel A (S8) and channel B (S10))	A TRIGGER SLOPE switch is provided to both channel A and channel B. When placed in the + position, triggering takes place on the positive slope of the input pulse. When the switch is placed in the - position, triggering takes place on the negative slope of the input pulse.
TRIGGER LEVEL Potentiometers (channel A (R2) and channel B (R3))	A TRIGGER LEVEL control knob permits balancing out any dc level in the input signal. This control also allows selection of any dc operating point between ±1 volt in the ATTENUATOR 1 position, to ±100 volts maximum in the ATTENUATOR 100 position.

TABLE 3-1. CONTROLS, INDICATORS, AND CONNECTORS ON FRONT AND REAR PANELS (Cont)

NAME	FUNCTION
ATTENUATOR rotary switches (channel A (S9) and channel B (S11))	Two rotary six position switches are provided. Three of the positions provide attenuation factors of 1, 10 and 100 for ac signal inputs. The other three positions provide the same attenuation factors for dc input signals.
SEP./COM. toggle switch (S13)	A two position switch which places the amplifiers into either a separate or common mode of operation.
A INPUT (J13) and B INPUT (J12) BNC connectors	The input signal to be measured is connected to the appropriate connectors.
REAR PANEL	
FUSE (F2)	A 0.5 Amp fuse which protects the oscillator power supply.
FUSE (F1)	A 1 Amp fuse which protects the Counter power supply.
FREQ. STD. BNC connector (J18)	The output at this BNC connector will be the reciprocal of the time setting of the TIME BASE SECONDS switch in the FREQ. A mode of operation.
1 MHz INT./EXT. toggle switch (S12)	When this switch is in the 1 MHz INT. position, the internal 1 MHz oscillator in the Counter is utilized. When this switch is in the EXT. position, an external 1 MHz signal is utilized by the Counter.
1 MHz IN BNC connector (J14)	The external 1 MHz is connected to this connector when the Counter is operated in the EXT. oscillator mode. Of course, the 1 MHz INT./EXT. toggle switch must be in the EXT. position.

d. Move FUNCTION switch to the PER. A position. Place TIME BASE SECONDS switch in the desired position.
e. Select the correct display time for this measurement. Refer to paragraph 3-18 if necessary.
f. Connect the A input signal to the A INPUT BNC connector.
g. Set TRIGGER LEVEL and ATTENUATOR controls so that reliable counting is maintained. The period of the input signal will be displayed on the Nixie tubes.

3-9. PER. A XM MODE OF OPERATION. In this mode of operation, the total of 10^M periods of the input signal is measured. The procedure is as follows:

a. Place POWER ON switch in the on position. The Nixie tubes shall glow.
b. Set STORE/TRACK switch in the STORE position.
c. Make connections on the rear panel BNC connectors, if this measurement requires it. Check to see that the 1 MHz INT./EXT. switch is in the appropriate position.
d. Place FUNCTION switch in the PER. A XM position.
e. Select the desired display time for this measurement. Refer to paragraph 3-18, if necessary.
f. Place TIME BASE SECONDS switch in one of the multiple positions.
g. Connect the A input signal to the A INPUT BNC connector.

h. Set TRIGGER LEVEL and ATTENUATOR controls so that reliable counting is maintained. The display on the Nixie tubes will indicate the average of periods measured as determined by the multiple selected by the TIME BASE SECONDS switch.

3-10. INTERVAL A TO B MODE OF OPERATION. In this mode of operation the A input opens the counting gate and the B input signal closes the counting gate. The time measured between these occurrences is displayed on the six Nixie tubes. Proceed as follows:

a. Place POWER ON switch in the on position. The Nixie tubes shall glow.
b. Place STORE/TRACK switch in the TRACK position.
c. Make connections to the rear panel BNC connectors if the requirements of this measurement necessitates it. Check to see if the 1 MHz INT./EXT. switch is in the correct position for either internal or external oscillator.
d. Select a display time. Refer to paragraph 3-18 for particulars.
e. Place TIME BASE SECONDS switch in the 1 10^{-6} position.
f. With FUNCTION switch in the PER. A position, connect the input signal to the A INPUT BNC connector. Adjust TRIGGER LEVEL control until a reliable count is maintained. The interval between the two repetitive signals will be displayed on the Nixie tubes.

3-11. RATIO B/A XM MODE OF OPERATION. In this mode of operation, the ratio between two frequencies is determined and displayed on the Nixie tubes. The input of channel A opens and closes the counting gate. Proceed as follows:

a. Place POWER ON switch to the on position. The Nixie tubes shall glow.
b. Make any required connections to the rear panel that are pertinent to the requirements of this measurement.
c. Set the STORE/TRACK switch to the TRACK position.
d. Select a display time with the DISPLAY TIME control. Refer to paragraph 3-18 for particulars.
e. Select a multiple (0 through 7) with the TIME BASE SECONDS switch. Depending on the input frequency, the 7 multiple will give the best resolution.
f. Place FUNCTION switch in the PER. A position. Connect the A input signal to the A INPUT BNC connector. Adjust the channel A TRIGGER LEVEL control so that a reliable count is maintained. Next, place FUNCTION switch in the RATIO B/A XM position. Connect the B input signal to the B INPUT BNC connector. Adjust the B TRIGGER LEVEL control until a reliable count is maintained. The ratio between the B and A frequencies will be displayed on the Nixie tubes.

3-12. SCALING MODE OF OPERATION. In this mode of operation, a frequency standard is produced for external applications. The input to channel A opens and closes the counting gate. The procedure of operation is as follows:

a. Place the POWER ON switch in the on position. The Nixie tubes shall glow.
b. Connect FREQ. STD. BNC connector to external equipment to be used.
c. Select scaling position on TIME BASE SECONDS switch to 1, 10 or 100.
d. Place the FUNCTION switch in the PER. A position. Connect the A input signal to the A INPUT BNC connector. Adjust the channel A TRIGGER LEVEL control so that a reliable count is maintained. Place the FUNCTION switch in the RATIO B/A XM position. The resultant output is a scale of the original input, determined by the positioned factor.

3-13. OPERATOR'S MAINTENANCE.

3-14. GENERAL. Operator's maintenance is any procedure which is performed within the capacity of an operator and is limited to procedures governing inspection, cleaning, adjustment and minor parts replacement.

3-15. INSPECTION. A periodic inspection of the Counter's chassis should be made to assure proper operation. A visible check of the Nixie tube readouts and the controls illustrated in figure 3-1 is recommended.

3-16. CLEANING. Cleaning is performed by the operator on all external parts of the Counter. The indicator should be cleaned at least every six months.

3-17. ADJUSTMENTS. Any external adjustments may be made by the operator. The procedures for adjustment of the TRIGGER SLOPE and TRIGGER LEVEL are covered in paragraph 3-17 and DISPLAY TIME adjustments are explained in paragraph 3-18.

3-18. The TRIGGER SLOPE switches allow selection of the positive or negative slope of the input signal being measured. The TRIGGER LEVEL control, used in conjunction with the ATTENUATOR control, will determine at what point on the slope triggering will take place. To assure that proper triggering is taking place, adjust the trigger level so that the Counter begins to count, then continue until the count stops. Finally, set the TRIGGER LEVEL control in the middle of those two points. If the amplitude of the input signal to be measured is not known, always place the ATTENUATOR switch in the highest position before connecting the signal to the Counter. The maximum allowable voltage input levels are listed in Table 1-1 of this manual. If the signal to be measured is low in frequency, but riding on a dc level, place the ATTENUATOR switch in the D. C. position. Use the TRIGGER LEVEL control to null out the dc so that the Counter can count.

3-19. The DISPLAY TIME is selected as follows:

a. Set the DISPLAY TIME control to some point between the MIN. and MAX. positions. This will allow the count to be displayed from 0.2 second to five seconds. As soon as the selected time has elapsed, the Counter will automatically reset and a new count will commence.

b. Set the DISPLAY TIME control to MANL. position. In this position, the counting gate will open for one count and that count will remain displayed on the Nixie tubes until the RESET pushbutton is pressed.

3-20. SEP./COM. SWITCH. The SEP./COM. switch provides separate or common inputs to the amplifier circuit of the Counter. For example if the time interval of one pulse is required, the amplifier when switched to the COM. position may deliver both the start and stop time of an input pulse to the Counter. The FUNCTION switch must be in the RATIO B/A XM position to obtain correct readings. When the switch is in the SEP. position both inputs are independent of each other.

3-21. MINOR PARTS REPLACEMENT. Minor parts replacement covers only parts which do not require the need of internal alignment or complex adjustment. Fuses and indicator lights (other than Nixie tubes) may be replaced by the operator.

SECTION IV

MAINTENANCE AND REPAIR

4-1. GENERAL

4-2. The maintenance and repair instructions contained in this section are for the Counter and its components and consist of circuit analysis, preventive maintenance, minimum performance tests, troubleshooting procedures, and repair and replacement procedures. Circuit analysis describes the theory of operation for each printed circuit card of the Counter, consistent with the maintenance requirements. Section VI of this manual contains an overall logic diagram of the Counter, schematic diagrams of the printed circuit cards, and a wiring diagram. These diagrams are included as detailed references for use when performing troubleshooting and maintenance procedures. The location and listing of component parts which constitute the Counter are contained in Section V.

4-3. CHANNEL A AND B AMPLIFIER. (See figure 6-2.) The theory of operation is identical for both channel A and B; therefore, only channel A will be described. The input signal is fed to a differential amplifier circuit which is designed to have no low frequency limitations and to maintain good temperature and drift stability. The amplifier allows easy cancellation of any dc component on the input signal since the output is proportional to the difference of the input signal. As much as 1.5 volts of dc input component can be balanced out by varying TRIGGER LEVEL potentiometer R2. The output of the differential amplifier circuit is fed to emitter follower Q6. The output of the emitter follower fires schmitt trigger Q7 and Q8 whenever the output signal rises above or falls below the threshold level of the schmitt trigger. The square wave output of schmitt trigger Q7 and Q8 is fed to another emitter follower, Q9. The output of Q9 is differentiated and applied to AND gate Q10 and inverter Q11. The inverted signal is fed to AND gate Q12 and, at this point, trigger slope selection occurs.

4-4. Assume that the TRIGGER SLOPE switch S10 is placed in the + position. This action places +10 volts on the base of AND gate Q10. This disables the gate since both AND gates will only open when negative inputs are present at both terminals. The incoming signal passes through inverter Q11. The signal that was positive now becomes negative and can pass through AND gate Q12. A phase inversion in the AND gate takes place so that the signal emerges as positive. This signal is coupled through a "wired-OR" gate, two inverter stages, Q13 and Q14, and emitter follower Q15 to the output of the amplifier. When the TRIGGER SLOPE switch is placed in the - position -10 volts appears at one terminal of AND gate Q12. The negative half cycle of the input signal passes through the AND gate and follows the same path to the output of the amplifier.

4-5. GATING LOGIC, CARD A10. (See figure 6-3.) When a gate trigger in pulse appears at the gate of card A10, it passes through diode AND gate CR1, CR2 and CR3, through emitter follower Q2, and sets the gate flip-flop Q3 and Q4. This action opens counting AND gate Q11 and Q12 so that the count can pass through to the decade readout circuits. The action also inhibits the input diode AND gate from letting any more pulses through. When a gate reset in pulse is introduced, it passes through emitter follower Q1 and through OR gate CR6 through CR9 which resets the gate flip-flop. This closes the counting AND gate and sets display flip-flop Q6 and Q7. In the changed state, the display flip-flop set output goes positive. This accomplishes two functions: it fires store monostable multivibrator Q16 and Q17; it starts the display time delay. The results of these functions are as follows:

a. If STORE/TRACK switch S4 is in the STORE position, the count in the decade readout cards is stored until the pulse is received from the store monostable multivibrator. Upon receipt of the store pulse, the count which has been registered on the decade flip-flop is now transferred to the storage flip-flop.

b. If switch S4 is placed in the TRACK position, the store monostable multivibrator acts as a 50 KHz astable generator. This 50 KHz signal is fed to the storage flip-flops on the decade readout cards and allows them to update fifty thousand times per second.

c. When the display time delay is initiated, the visual display of the count is maintained on the six Nixie tubes until the end of the delay time selected. When the delay time selected has elapsed, the delay circuit fires through the reset OR gate to trigger reset mono Q14 and Q15 to momentarily change state. When the RESET MONO changes state, it resets the display ff flip-flop Q6 and Q7, resets all counting decades to zero, and resets triple decade card A8 and single decade card A13. The Counter has now completed one cycle and is ready for the next count.

4-6. To reset the Counter manually, RESET switch S2 must be pressed. The manual reset pulse resets the gate ff flip-flop Q3 and Q4 through OR gate CR6 and CR7, and triggers the reset mono and store mono through OR gates CR18 and CR19, and CR21 and CR22.

4-7. TIME BASE DECADES, CARDS A7, A8, and A13. (See figures 6-4 through 6-6.) The gate times that are selected by the TIME BASE seconds switch S7, are derived from printed circuit cards A7, A8, and A13. Cards A7 and A8 each contain three decade

circuits and card A13 contains a single decade circuit. The output of each decade is applied to switch S7 and to the input of the next decade. The input to the first decade on card A7 is the 1 MHz signal from the internal oscillator (card A12) or an external oscillator. The 1 MHz signal is divided by ten in the first decade (100 KHz), by ten in the second decade (10 KHz) and again by ten in the third decade (1 KHz). The 1 KHz output, of the first triple decade, is the input to the next triple decade and it is divided down to outputs of 100 Hz, 10 Hz, and 1 Hz. The 1 Hz output is fed to card A13 which divides the 1 Hz to 0.1 Hz. The 1 Hz decade on card A8 and the 0.1 Hz decade on card A13 are both reset at the end of each count. This assures that there is no more than 0.1 of a second delay before a new gate open pulse can be generated even though the TIME BASE SECONDS switch may be in the 10 or 1 position.

4-8. DECADE READOUT, CARDS A1 THROUGH A6. (See figures 6-7 through 6-9.) There are six decade readout cards in the Counter. Each decade counts up to 9 and then overflows into the next decade. The total count from the six cards can be 999,999. Each decade readout has three main sections: a decade section; four storage flip-flops; and a resistor gate matrix.

4-9. Firstly, the decade section contains four flip-flops with appropriate feedback to give a total count of ten. Before the count starts, all four flip-flops are in the reset position. The first input pulse sets the first flip-flop; the second input pulse resets it, and sets the second flip-flop; the third input pulse sets the first flip-flop again, leaving the second one set. The fourth input pulse resets the first flip-flop, resetting the second, which sets the third. To summarize at this point, the flip-flops are in the following condition; No. 1 is reset, No. 2 is reset, No. 3 is set, and No. 4 is reset.

4-10. The fifth input pulse sets the first flip-flop, leaving the rest unchanged. The sixth input pulse resets the first flip-flop, setting the second. The seventh input pulse sets the first flip-flop. Now all of the first three flip-flops are set and only the last is reset. Normally, at this point, the next pulse would result in the expected behavior; that is, the fourth flip-flop would be set, and all the other three would be reset. However, a feedback connection has been provided so that the act of setting the fourth also sets the second and third. This action actually contradicts the normal 1-2-4-8 binary order and has the effect of adding six extra counts to the normal 16 count action of a four stage binary counter reducing its actual count capacity to 10 counts. The eighth pulse, therefore, leaves the first flip-flop reset and all the rest set. The ninth and last pulse in the sequence sets the first flip-flop, so that all flip-flops are now set.

4-11. The next pulse to enter the Counter (the tenth pulse) resets all four flip-flops, so that the Counter has been returned to its original state. When this occurs, a carry pulse is fed to the next decade. This pulse is provided by the fourth flip-flop as it resets. The set terminal goes positive "0" at that instant, and a positive pulse is delivered to the trigger input terminal of the succeeding decade counter.

4-12. Secondly, the four storage flip-flops control the display while storing information which has been transferred to them. The storage flip-flops do not change state until receipt of a pulse commanding them to do so. At the time this pulse is received, the storage flip-flop takes on the state of the decade flip-flop which drives it. With the STORE/TRACK switch in the STORE position, the storage flip-flops do not update until the count has been completed. At this time the store mono (located on gating logic card) delivers a pulse to all storage flip-flops simultaneously. The count which has been registered on the decade flip-flops, is now transferred to the storage flip-flops. When the STORE/TRACK switch is in the TRACK position, the store mono acts as a 50 KHz astable generator. This 50 KHz signal at the storage flip-flop allows them to update 50 thousand times per second.

4-13. Finally, the correct numerical display is provided by encoding the outputs of the four storage flip-flops through a resistor gate matrix. All inputs to any one gate must be grounded to open the gate. The output of each gate is fed to a Nixie cathode amplifier. The output of the amplifier causes the Nixie cathode to go to zero and ionization potential is reached between the cathode and the common anode. This causes the number to light in the Nixie tube. As the count commences, the first gate closes and the next gate opens. That number in the Nixie tubes is illuminated.

4-14. CHARACTER AND DECIMAL POINT, TB2. (See figure 6-10.) The character and decimal point terminal board contains diode gates which control the character and decimal point readout. An additional emitter follower circuit provides a frequency standard for external use.

4-15. As FUNCTION switch S6 and TIME BASE SECONDS switch S7 are positioned, -8 volts is applied to one of the six character diode gate inputs. If for example -8 volts is applied to the uS terminal (E18) it causes the u and the S characters on the Nixie tube to light. The diodes are connected and biased so no other characters are displayed.

4-16. The decimal point inputs are connected directly to switch S7. One of the three decimal point neons (NE1, NE2, or NE3) lights when the TIME BASE SECONDS switch is positioned.

4-17. The emitter follower circuit is connected between the time base output and the FREQ. STD BNC connector. This permits signals from the three decade counters to pass through and provide frequency standards of 1 MHz, 100 KHz, 10 KHz, 1 KHz, 100 Hz, 10 Hz, 1 Hz, and 0.1 Hz, depending upon switch selection.

4-18. OSCILLATOR, CARD A12. (See figure 6-11.) The oscillator circuit is controlled by switch S12. Switch S12 has two positions: the first position

connects internal crystal oscillator X1 to a two state amplifier and the second position allows the use of an external oscillator. The output of the oscillator is a reference signal of 1 MHz used for internal timing.

4-19. POWER SUPPLY, CARD A11. (See figure 6-12.) Four separate voltages are developed by the power supply card. These are:

a. 300 vac halfwave rectified by diode CR10 to provide 300 vdc.
b. 30 vdc halfwave rectified by diode CR9 and fed through a double series regulator circuit. The first regulator, Q3, filters and regulates any large fluctuations in the input line. The output of Q3 is steady. The second regulator, Q5, provides fine filtering and regulation of the +10 vdc supply voltage.
c. A 15 vac signal is applied to a fullwave bridge rectifier. The output of the rectifier is fed through a filter and a voltage divider to provide output of -10 vdc and -7.5 vdc.

4-20. PREVENTIVE MAINTENANCE.

4-21. Preventive maintenance consists of inspection, cleaning procedures, and minimum performance tests required to maintain the proper equipment operating level. Since the Counter's operating environment varies, it is impractical to set forth specific preventive maintenance schedule; however, it is suggested that a schedule be made up and adhered to in order to prevent equipment failure due to dust, dirt, condensation, and other accumulating type materials.

4-22. GENERAL SCHEDULING REQUIREMENTS. At periodic intervals, the Counter should be removed from the cabinet and thoroughly inspected and cleaned externally and internally.

WARNING

When using a cleaning solvent, be careful.

4-23. Accumulating type materials should be removed with a soft brush, rag, vacuum cleaner or suitable solvent. After completing the schedule, the Counter should be re-installed. Either before or after re-installation, all of the Counter's operating modes should be exercised using the minimum performance tests contained in paragraphs 4-24 through 4-32. These tests may disclose an impending or existing malfunction if the Counter is normally used with limited operational modes.

4-24. FREQUENCY MEASUREMENT AND SENSITIVITY TEST. Test the Counter for frequency and sensitivity as follows:

a. Connect a BNC tee connector to the standard frequency output of the high frequency counter. Terminate one side of the tee with a 50-ohm load. Connect the other side of the tee, through an appropriate attenuator, to the equipment and to a voltmeter.
b. Set the appropriate front panel controls to put the Counter into the frequency function.
c. Select gate times indicated in table 4-1.
d. Set the standard frequency outputs of the high frequency counter to each of its positions from 10 Hz to 1 MHz and adjust the attenuator for 100-mv signal level into the equipment.
e. The readings may deviate from the indications in table 4-1 by ±2 counts of the least significant digits.
f. Repeat procedure using gate times for minimum accuracy. Record all readings.

4-25. PERIOD MEASUREMENT AND SENSITIVITY TEST. Period measurement and sensitivity tests are performed as indicated in the following procedure and table 4-2.

a. Connect the known output of the high frequency counter (see paragraph 4-24) to the equipment and to a voltmeter which is capable of measuring signals from 0 to 1 MHz with at least 10-mv full scale sensitivity and ±5 percent accuracy.
b. Set the appropriate front panel controls to put the Counter into the period function.
c. Select the 1 MHz clock frequency (1 usec).
d. Select the number of periods averaged as shown in table 4-2.
e. Repeat the above measurements of 10 Hz, 100 Hz, and 1 KHz, using the sine wave output of the function generator. The above readings may deviate by the above indicated counts or ± trigger error.

4-26. INTERNAL FREQUENCY STANDARD SHORT TERM STABILITY TEST. The procedure for testing the internal frequency standard short term stability is as follows:

a. Allow the Counter under test to warm-up at least 2 hours.
b. Connect the 1 sec. standard frequency output from the counter under test to the "B" input of the high frequency counter and set it for 1000 period measurement with 10^5 Hz clock frequency.
c. The reading on the high frequency counter shall be 000000.00 20 counts.
d. Record the readings using the bcd output of the high frequency counter.

4-27. STANDARD FREQUENCY OUTPUT TESTS. Standard frequency outputs are tested as follows:

a. Connect the standard frequency output of the Counter under test to the input of the oscilloscope and the "B" input of the high frequency counter set for a period average measurement as shown in table 4-3.
b. The amplitude of each standard frequency output, as measured on the oscilloscope shall be shown in table 4-3.
c. The frequency of each standard frequency output as measured on the high frequency counter shall be as shown in table 4-3.

TABLE 4-1. FREQUENCY MEASUREMENT AND SENSITIVITY, TEST SETTING AND RESPONSE

High Frequency Counter	Gate Time	Signal Level	Six digits Reading	Units
10 Hz	10 sec.	100 mv	00.0100	KHz
100 Hz	10 sec.	100 mv	00.1000	KHz
1 KHz	10 sec.	100 mv	01.0000	KHz
10 KHz	1 sec.	100 mv	010.000	KHz
100 KHz	0.1 sec.	100 mv	0100.00	KHz
1 MHz	10 ms.	100 mv	01000.0	KHz

TABLE 4-2. PERIOD MEASUREMENTS AND SENSITIVITY, TEST SETTINGS AND RESPONSE

Periods Averaged	Input Frequency	Signal Level	Indication
1	10 Hz	100 mv	00100.0 ±2 ms
10	100 Hz	100 mv	0010.00 ±2 ms
100	1 KHz	100 mv	001.000 ±1 ms
100	10 KHz	100 mv	000.100 ±1 ms
100	100 KHz	100 mv	000.0.0 ±1 ms

TABLE 4-3. STANDARD FREQUENCY OUTPUTS, TEST SETTINGS AND RESPONSE

Standard Freq. Output	Approx. minimum peak amplitude	No. of periods averaged	Reading on high freq. counter	Units
0.1 Hz	1.5 volts	1	10000000.	usec.
1 Hz	1.5 volts	1	01000000.	usec.
10 Hz	1.5 volts	10	0100000.0	usec.
100 Hz	1.5 volts	10^2	010000.00	usec.
1 Hz	1.5 volts	10^3	01000.000	usec.
10 Hz	1.5 volts	10^4	0100.0000	usec.
100 KHz	1.0 volt rms or 1.5 volts	10^5	001.00000	usec.
1 MHz	1.0 volt rms	10^5	001.00000	usec.

4-28. EXTERNAL STANDARD FREQUENCY INPUT (MHz) TEST. To test the external standard frequency input proceed as follows:

a. Connect a 1 MHz standard output of a high frequency counter to the external standard input of the equipment through an appropriate attenuator. Set the input level to the equipment to 1.0 vrms and monitor with L.F. VTVM.
b. Set the equipment to operate with external standard. Perform the self-check test (see Section III) and record the readings.

4-29. FREQUENCY RATIO MEASUREMENTS TEST. The following procedure and table 4-4 are used in testing frequency ratio measurements.

a. Connect the standard frequency outputs of the high frequency counter to the numerator input of the equipment and to a vtvm.
b. Connect the function generator to the denominator input.
c. Set the appropriate front panel controls to put the equipment into the ratio function.
d. Select the number of periods averaged and frequency as indicated in table 4-4 (maintain minimum input signals).

TABLE 4-4. FREQUENCY RATIO MEASUREMENTS, TEST SETTINGS AND RESPONSE

High frequency Counter	Function generator	Periods AVG	Indicated ratio
1 MHz	1 KHz	1	1000:1
1 MHz	1 KHz	10	1000.0:1
1 MHz	1 KHz	10^2	000.00:1
100 KHz	1 KHz	10^2	100.00:1
10 KHz	100 Hz	10^2	100.00:1
1 KHz	10 Hz	10^2	100.00:1
1 KHz	1 KHz	1	1:1
1 KHz	1 KHz	10	1.0:1
1 KHz	1 KHz	10^2	1.00:1

4-30. TIME INTERVAL MEASUREMENTS TEST. Test the time interval measurements of the Counter as follows:

a. Connect the standard frequency outputs of the high frequency counter to the input of the Counter under test.
b. Set the equipment for time interval operation. Select common line input and set start and stop slope selectors as shown in table 4-5.
c. Select the standard frequency outputs from the high frequency counter as shown in table 4-5.
d. Select 100 KHz clock frequency.
e. The readings may deviate from the above indications by ±1 count.

TABLE 4-5. TIME INVERVAL MEASUREMENTS, TEST SETTINGS AND RESPONSE

Standard freq. output	Start slope	Stop slope	Reading	Units
10 KHz	+	+	0000.10	ms
10 KHz	+	-	0000.02	ms
10 KHz	-	+	0000.08	ms
10 KHz	-	-	0000.10	ms
10 Hz	+	+	0100.00	ms
10 Hz	+	-	0020.00	ms
10 Hz	-	+	0080.00	ms
10 Hz	-	-	0100.00	ms
1 KHz	+	-	0000.20	ms
1 KHz	-	+	0000.80	ms
.1 Hz	+	-	02000.0	ms
.1 Hz	-	+	08000.0	ms

4-31. SCALING TEST. The scaling test is performed in the following procedures and table 4-6.

a. Connect the generator with its output set at 1 volt, rms to the signal input of the equipment. Set its frequency to approximately 1 KHz.
b. Connect the high frequency counter to the frequency standard output connector at the rear of the equipment.
c. Set the appropriate front panel controls to put the instrument in a scaling function.
d. Set the scale ratio as indicated in table 4-6.
e. The reading may deviate from the indications in table 4-6 by ±2 counts.

TABLE 4-6. SCALING, TEST SETTING AND RESPONSE

Input freq.	Scaler ratio	Reading on high freq. counter	Units
1 KHz	1	00001.000	KHz
1 KHz	10	00000.100	KHz
1 KHz	100	00000.010	KHz

4-32. STORAGE TEST. The Counter's storage is tested as follows:

a. Connect the high frequency counter "std. freq. out" to the frequency input connector of the equipment. Set the frequency out to 100 KHz. Note that the display remains on 100.00. Change the frequency to 10 KHz. Record whether or not only the final count is displayed

b. Disable the storage feature.
c. Change the high frequency counter frequency back to 100 KHz.
d. Record whether or not the counting action may be observed.
e. Switch "storage" back in.
f. Change the frequency to 10 KHz.
g. Record whether or not only the final count shall be observed.

4-33. REPAIR AND REPLACEMENT.

4-34. Repair and replacement procedures for the Counter are performed in a straightforward manner and require no unusual techniques. Component parts and printed circuit cards are accessible by removing the top cover of the Counter. When replacing parts, refer to Section V for the location and listing of component parts. Printed circuit cards may be removed by first removing the thumbscrews that secure the cards in place. The cards may now be tilted up and unplugged from their receptacles. When installing the printed circuit cards, observe the color codes per table 4-7.

4-35. CALIBRATION OR ADJUSTMENTS.

4-36. Calibration or adjustments are required either before or after troubleshooting or replacement of parts to maintain efficient Counter operation.

4-37. POWER SUPPLY VOLTAGE CHECKS AND ADJUSTMENTS. Place the Counter on a work bench and remove the top cover. Plug the power cord into a 115 vac source and place the POWER ON switch in the on position. With a voltmeter, measure voltage between ground and the terminals listed in table 4-8.

NOTE

The -10 VDC supply is adjusted by varying potentiometer A11R4 (See figure 6-12).

4-38. AMPLIFIER ADJUSTMENT. (See figure 6-2). This adjustment may be necessary after replacing amplifier cards or power supply cards as well as replacement of components on the amplifier card. The procedure is as follows:

a. With power off, remove decade printed circuit cards. Set the A and B ATTENTUATOR switches to the D.C. 1 position. With a signal generator, apply a 280-mv peak-to-peak 1 MHz sine wave to the channel A INPUT BNC connector. Attach a 10X probe from an oscilloscope to pin 13 of amplifier card A9. Trigger the oscilloscope for a positive-going pulse.
b. Place the POWER ON switch in the on position, rotate the TRIGGER LEVEL control to its counter clockwise position and slowly rotate it in a clockwise direction until a positive pulse is observed at pin 13. Adjust the input amplitude and TRIGGER LEVEL control simultaneously to find the smallest amplitude that will give an output pulse from pin 13.

NOTE

If necessary, use the 19-pin extender card.

c. Disconnect the input cable from the 1 MHz source and connect it to the 1 megohm input of the oscilloscope. Adjust potentiometer A9R3 to bring the dc voltage at channel A INPUT BNC connector to ground potential.
d. Return the input cable to the 1 MHz source and re-adjust the TRIGGER LEVEL control to its most sensitive position. Alternately adjust the TRIGGER LEVEL control and potentiometer A9R3 until the input voltage remains at ground potential and the TRIGGER LEVEL control is at its most sensitive position.

e. Adjust the B channel in a similar manner. The input should be connected to the channel B INPUT BNC connector and the 10X oscilloscope probe should be connected to the B output pin 7.

TABLE 4-7. PRINTED CIRCUIT CARD COLOR CODES

Card Reference Designation	Title No.	Color Code
A1	Decade Readout No. 14	Green
A2	Decade Readout No. 14	Green
A3	Decade Readout No. 14	Green
A4	Decade Readout No. 14	Green
A5	Decade Readout No. 13	Red
A6	Decade Readout No. 12	Orange
A7	Triple Decade - Fast	Violet
A8	Triple Decade - Slow	Clear
A9	Channel A and B Amplifier	Blue
A10	Gating Logic	Yellow
A11	Power Supply	Black
A12	Oscillator	Blue
A13	Single Decade	White

TABLE 4-8. VOLTAGE CHECKS

Location	Voltage
TB1-2	-10 ±1.0 volts DC
TB1-3	+300 volts DC ±10 percent
TB1-4	-7.5 ±0.4 volts DC
TB1-5	+10 ±1.0 volts DC

NOTE

Steps f and g are necessary if the power supply card A11 has been changed or components on A11 have been replaced. The purpose is to establish electrical zero for the TRIGGER LEVEL control.

f. Connect a 280-mv peak-to-peak 1 MHz sine wave input to channel A INPUT BNC connector and TRIGGER LEVEL control to within 15 degrees of vertical by changing the value of the resistor (on amplifier chassis connector), if necessary.

g. Connect a 280-mv peak-to-peak MHz sine wave input to the channel B INPUT BNC connector and the 10X oscilloscope probe on the channel B output pin 7. Center the TRIGGER LEVEL control to within 15 degrees of vertical by changing the value of the resistor (on amplifier chassis connector) if necessary.

h. Place the POWER switch in the off position. Install all the printed circuit cards and install the top cover.

4-39. OSCILLATOR FREQUENCY ADJUSTMENT. (See figure 6-11). To align the crystal oscillators' frequency proceed as follows:

a. Remove top cover from Counter and plug power cord into a 115 vac line source. Turn POWER ON switch to the on position.

b. Set up an oscilloscope to monitor a 1 MHz signal using an external 1 MHz signal generator to trigger the oscilloscope.

c. Connect the oscilloscope to the FREQ. STD. output BNC connector mounted on the rear of the Counter.

d. Place the TIME BASE SECONDS switch on the front panel of the Counter at 10^{-6} position.

e. Adjust trimmer capacitor C7 until a stable 1 MHz Lissajous pattern is observed on the oscilloscope.

NOTE

The Lissajous pattern may change direction as the oscillator's oven switches on and off. If the pattern does not hold a stable setting the oven has not warmed up completely; allow 30 minutes to warm up and adjust again.

f. Check junction of coil L1 and collector of Q2 for an appropriate 3-volt peak-to-peak signal, if necessary adjust coil L1. (Refer to paragraph 4-40.)

4-40. With an oscilloscope set up to monitor a 1 MHz, 3-volt peak-to-peak signal, observe a 1 MHz signal at the junction of L1 and the collector of Q2.

a. Rotate coil slug of L1 counter clockwise from maximum clockwise position until maximum signal appears on the oscilloscope.

b. Rotate slug of L1 clockwise until a 3-volt peak-to-peak signal is observed.

c. Switch POWER ON switch to the off position for a few seconds and then back to on. The signal should appear immediately on the oscilloscope.

d. Remove power inputs and test equipment; replace top shield.

4-41. TROUBLESHOOTING.

4-42. Troubleshooting procedures are outlined in tabular form in table 4-9. Before troubleshooting the Counter, the user should be thoroughly familiar with the theory of operation and operating instructions. When performing troubleshooting procedures, refer to the diagrams provided in Section VI and to the part location data contained in Section V.

TABLE 4-9. TROUBLESHOOTING

Trouble	Probable Cause	Remedy
POWER ON switch on, Nixies do not light	Power Supply	a. Check fuse and replace if needed. b. Check ac inputs and dc outputs of card A11. If proper inputs are not obtained trace source of input. If inputs are correct but outputs are not obtained, replace card A11. c. Check POWER ON switch, replace if defective.
Nixies light, but are blurred	-10v power supply	a. Check input and output of -10v power supply. b. Check bridge diodes CR1 through CR4. c. Check output of -10v supply at pin 10, if incorrect replace card A11.

TABLE 4-9. TROUBLESHOOTING (CONT)

Trouble	Probable Cause	Remedy
No operation in TEST mode. (display all zeros)	Oscillator not operating	a. Correct external oscillator (1 MHz) to check display, replace crystal if defective.
	Gating logic card inoperative	b. Check a gate output and count out on gating logic cards for pulse output.
	Readout circuit	c. Check first readout card, replace if defective.
In TEST mode the Counter operates in some time bases but not in others.	TIME BASE counter cards	a. Replace switch
	Decade counter cards	b. Check the decade counter associated with the inoperative setting of the TIME BASE SECONDS switch, replace if needed.
	Readout Circuitry	c. If Nixie tubes 4, 5, and 6, 5 and 6, or 6 check flip-flops of first circuit in the chain. If only one Nixie tube does not light, replace tube.
One number of display blurred or more than one element lights.	Nixie tubes	a. Check tube and replace, if required.
	Driver circuit	b. Check driver circuit associated with the number involved.
No reset present with unit in TRACK and DISPLAY TIME switch in variable position (other than manual)	Gating logic card A10	Replace card A10
	STORE/TRACK switch inoperative	Replace switch
Counter operates in TEST MODE, but does not count when external input is applied.	Amplifier card A9	a. Replace amplifier card A9 b. Adjust TRIGGER LEVEL control as performed in Operation Section paragraph 3-18.
Counter operates in only FREQUENCY, PERIOD, and TEST modes.	Channel B amplifier card A9	Replace card A9

SECTION V

PARTS LIST

5-1. INTRODUCTION .

5-2. GENERAL. This section contains the lists and illustrations of the maintenance parts for the Counter, Electronic, Digital Readout AN/USM-245A. The lists are presented in tabular form and contain the information described in the following paragraphs.

5-3. REFERENCE DESIGNATION OR INDEX NUMBER. The reference designation or index number column lists the electrical parts alphabetically by circuit reference designation (where applicable) and the mechanical parts by index number. The parts are identified on the associated illustrations by the corresponding reference designations or index numbers.

5-4. PART NUMBER. The part numbers listed in this column are those of the prime contractor, the design vendor, or the government agency through which it is promulgated.

5-5. DESCRIPTION. The description column contains the basic name of the part and any descriptive information necessary for its identification.

5-6. MANUFACTURER'S CODE. This column lists the code assigned by the Federal Supply Code for Manufactuers Cataloging Handbooks H4-1 and H4-2. A listing of applicable Manufacturer's Codes will be found at the end of this section.

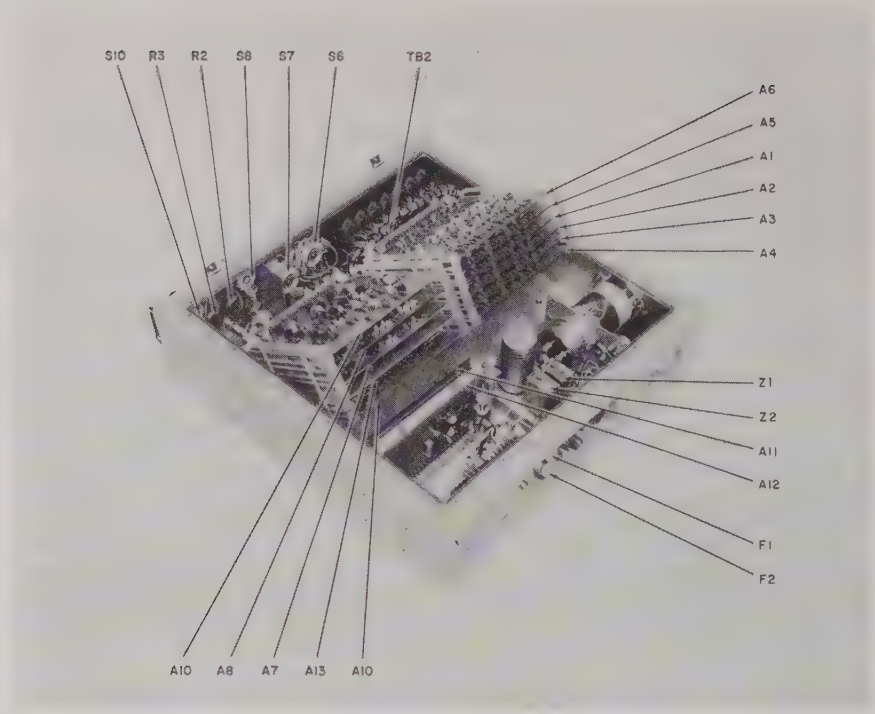
5-7. QUANTITY PER ASSEMBLY. The quantity per assembly column indicates the total quantity of a particular part used in the assembly in which it is listed.

MAJOR ASSEMBLIES

Fig. No.	Part No.	Description		Qty Per Equip.
5-1	A-361/M3	Counter, Electronic, Digital Readout AN/USM-245A		
5-2	A-1001-RW/ST	Decade Readout	A1 thru A4	4
5-3	A-1002-RW/ST	Decade Readout	A5	1
5-4	A-1003-RW/ST	Decade Readout	A6	1
5-5	A-3107-1	Triple Decade	A7	1
5-6	A-3108-A	Slow Triple Decade	A8	1
5-7	A-1050	Channel A and B Amplifier	A9	1
5-8	A-1057	Gating Logic	A10	1
5-9	A-1053	Power Supply	A11	1
5-10	A-1054	Oscillator Board	A12	1
5-11	A-1056	Single Decade	A13	1

COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-245A
(SEE FIGURE 5-1)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
C1	32D452G035BC6B	CAPACITOR, FIXED, ELECTROLYTIC, 4200 uf, ±75%, 35V	56289	1
C2	BT8V350	CAPACITOR, FIXED, Metallized paper, 8 uf, 350V	00656	1
C3	BT50V50	CAPACITOR, FIXED, Metallized paper, 50 uf, 50V	00656	1
C5	5C11	CAPACITOR, FIXED, Ceramic, 0.47 uf, 25V	91418	1
F1	1-3AG	FUSE, CARTRIDGE	75915	2
F2		(SAME AS F1)		
J12 thru J14	UG-657/U	CONNECTOR, RECEPTACLE, ELECTRICAL	81349	3
J18		(SAME AS J12)		



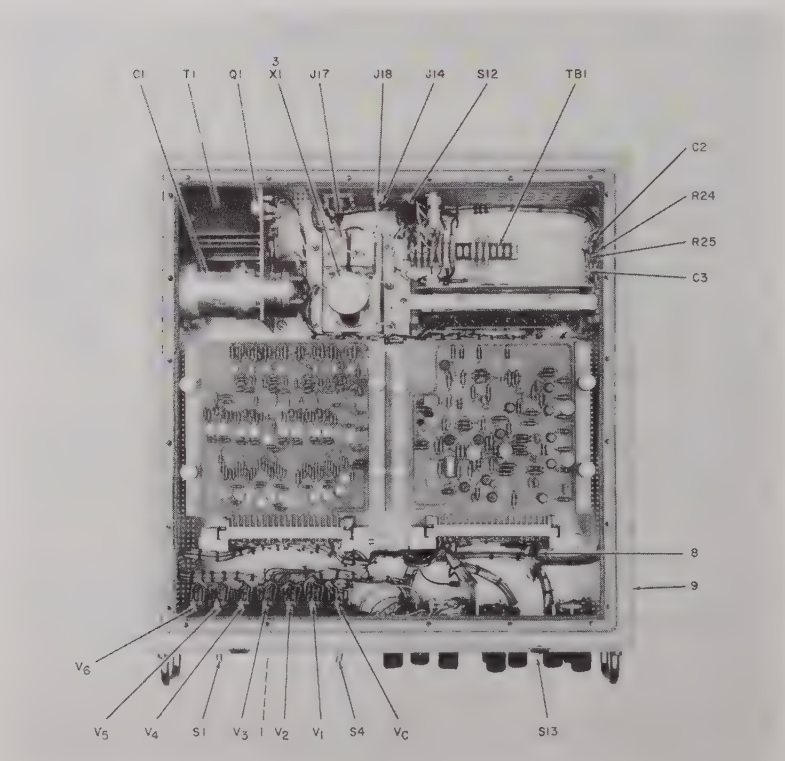


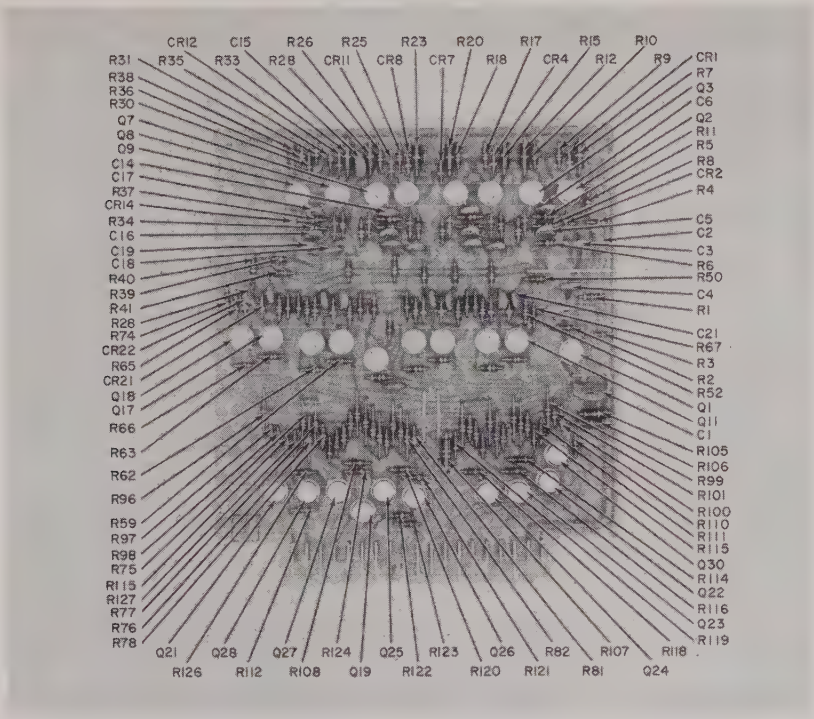
Figure 5-1. Counter, Electronic, Digital Readout AN/USM-245A

COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-245A (Cont)
(SEE FIGURE 5-1)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
Q1	2N2152	TRANSISTOR	04713	1
R1	CU-2541	RESISTOR, VARIABLE	44655	1
R2	CU-1521	RESISTOR, VARIABLE	44655	2
R3		(SAME AS R2)		
R10	CB4721	RESISTOR, FIXED, COMPOSITION, 4.7K ±10%, 1/4W	01121	2
R11	EB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10% 1/2W	01121	2
R17		(SAME AS R10)		
R18		(SAME AS R11)		
R24	EB2241	RESISTOR, FIXED, COMPOSITION, 220K ±10% 1/2W	01121	2
R25		(SAME AS R24)		
S1	MS25100-22	SWITCH, TOGGLE	96906	1
S2	B-2001	SWITCH, PUSH, SPST	81640	2
S3		(SAME AS S2)		
S4	PA116-171	SWITCH, ROTARY	95624	1
S5	CS1	SWITCH, ADJUSTABLE	44655	1
S8	SW-G-124	SWITCH, TOGGLE	79721	2
S10		(SAME AS S8)		
S12	MS25098-23	SWITCH, TOGGLE	96906	1
S13	7201	SWITCH, TOGGLE	09253	1
T1	S35819	TRANSFORMER	15356	1
TB1	410-15	TERMINAL BOARD	75382	1
V1 thru V6	NL5961	NIXIE TUBE	83781	6
V7	NL5964	NIXIE TUBE	83781	1
XF1	FHN26G	FUSEHOLDER	81349	2
XF2		(SAME AS XF1)		
-1	644-B-122	WINDOW	15356	1
	A-1070	ATTENUATOR ASSEMBLY	15356	1
C10	5GA-S10	CAPACITOR, FIXED, CERAMIC, 0.01 uf, 1000V	56289	2
C11		(SAME AS C10)		
C12	DM-10-020J	CAPACITOR, FIXED, CERAMIC, 7 uuf, ±5%, 500V	72136	4
C13	DM-10-910J	CAPACITOR, FIXED, CERAMIC, 91 uuf, ±5%, 500V	72136	4
C14		(SAME AS C13)		
C15		(SAME AS C12)		
C16 thru C19		(SAME AS C13)		
R12	CB1061	RESISTOR, FIXED, COMPOSITION, 10 Mego ±10%, 1/4W	01121	4
R13	CB1081	RESISTOR, FIXED, COMPOSITION, 1000 Mego ±10%, 1/4W	01121	2
R14	CB1071	RESISTOR, FIXED, COMPOSITION, 100 Mego ±10%, 1/4W	01121	4
R15		(SAME AS R14)		
R16		(SAME AS R12)		
R19		(SAME AS R12)		
R20		(SAME AS R13)		
R21		(SAME AS R14)		
R22		(SAME AS R14)		
R23		(SAME AS R12)		
S9	1376705	SWITCH, ROTARY	71450	2
S11		(SAME AS S9)		
	A-1080	MAIN HARNESS ASSEMBLY	15356	1
J7 thru J11	5007-019-190-001	CONNECTOR, RECEPTACLE ELECTRICAL	91662	5
A-1032	A-1082	NIXIE ELCO ASSEMBLY	15356	1
J1 thru J6	5007-019-190-001	CONNECTOR, RECEPTACLE° ELECTRICAL	91662	6
	A-1081	NIXIE, ASSEMBLY	15356	1
NE1 thru NE3	5AH-A	LAMP, Neon	08806	3
TB2	A-1060	NIXIE CHARACTER BOARD	15356	1

COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-245A (Cont)
(SEE FIGURE 5-1)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
CR1 thru CR6	CER70A	SEMICONDUCTOR DEVICE, DIODE	13327	6
C1	150D185X9015A-2	CAPACITOR, FIXED, ELECTROLYTIC, 1.8 uf, ±10%, 15V	56289	1
L1	MS18130-20	CHOKE, Radio frequency	96906	1
Q1	Q-1002	TRANSISTOR	15356	1
R1 thru R5	CB1041	RESISTOR, FIXED, COMPOSITION, 100K ±10%, 1/4W	01121	5
R6 thru R8	EB2241	RESISTOR, FIXED, COMPOSITION, 220K ±10%, 1/2W	01121	3
R9	EB4711	RESISTOR, FIXED, COMPOSITION, 470 ohms ±10%, 1/2W	01121	1
R10	EB1011	RESISTOR, FIXED, COMPOSITION, 100 ohms ±10%, 1/2W	01121	1
TB1	644-C-135	PRINTED CIRCUIT BOARD	15356	1
XV1 thru XV7	SK136	SOCKET	83781	7
	A-1083	HARNESS ASSEMBLY	15356	1
J15	5007-019-190-001	CONNECTOR, RECEPTACLE, ELECTRICAL	91662	2
J16		(SAME AS J15)		
	A-1084	SWITCH ASSEMBLY	15356	1
R4	CB1015	RESISTOR, FIXED, COMPOSITION, 100 ohms ±10%, 1/4W	01121	2
R5		(SAME AS R4)		
S6	212-20550-3	SWITCH, ROTARY	91662	1
S7	212-20549-6	SWITCH, ROTARY	91667	1
	A-1085	CRYSTAL AND RFI ASSEMBLY	15356	1
C6 thru C9	DD-203	CAPACITOR, FIXED, CERAMIC	71590	4
L1	1331-35	CHOKE, Radio frequency	82142	2
L2		(SAME AS L1)		
X1	TS101PO1	SOCKET, ELECTRON TUBE	81349	1
Z1	A1023	FILTER, RFI	18621	2
Z2		(SAME AS Z2)		
-2	MS91528-1E2B	KNOB	96906	9
-3	NE461	CRYSTAL OVEN ASSEMBLY	94066	1
-4	UG-255/U	ADAPTER	81349	1
-5	UG-273/U	ADAPTER	81349	1
-6	UG-274/U	ADAPTER, TEE	81349	1
-7	UG-1090/U	ADAPTER	81349	1
-8	MS3057-6	CLAMP, LOOP	96906	1
XF1	FHN-26G	FUSEHOLDER	75915	2
XF2		(SAME AS XF1)		
	A-3011	CABLE ASSEMBLY	15356	1
-9	ZX4093	GASKET	76385	1
-10	HC200-SS	LATCH	98002	4
-11	6012-16AN	CLIP	91506	3



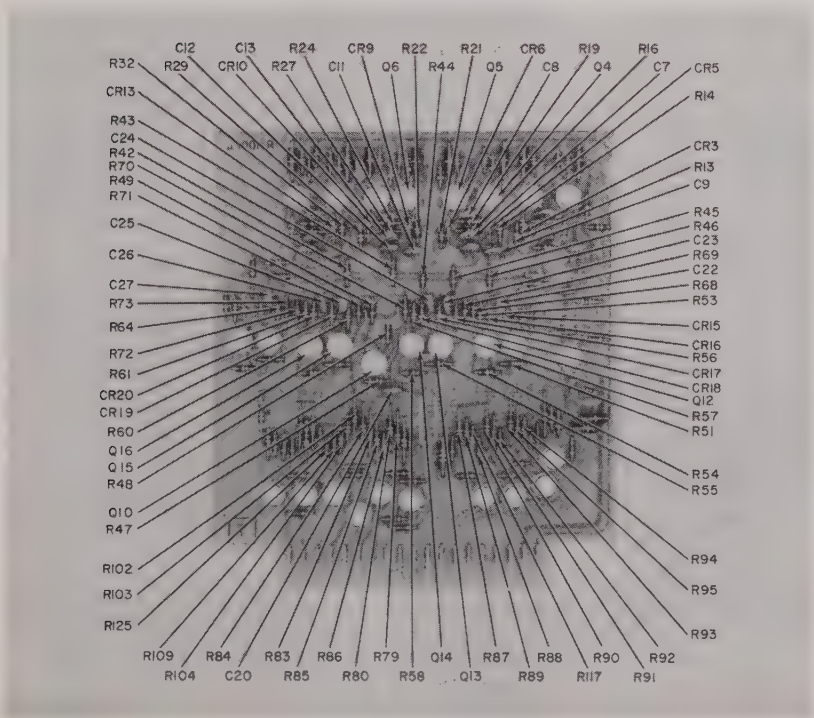


Figure 5-2. Decade Readout, Cards A1 through A4

DECADE READOUT, CARDS A1 THROUGH A4
(SEE FIGURE 5-2)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
CR1 thru CR22	1N191	SEMICONDUCTOR DEVICE, DIODE	05292	22
C1	.003JF-10%	CAPACITOR, FIXED, CERAMIC, 0.003 uf ±10%, 1KV	91418	1
C2	.001JF-10%	CAPACITOR, FIXED, CERAMIC, 0.001 uf ±10%, 1KV	91418	2
C3 thru C14	220JF-10%	CAPACITOR, FIXED, CERAMIC, 200 uuf	91418	25
C15		(SAME AS C2)		
C16 thru C28		(SAME AS C3)		
Q1 thru Q18	2N404	TRANSISTOR, Germanium, PNP	02735	18
Q19 thru Q28	G-1002-1	TRANSISTOR	15356	10
R1	CB4731	RESISTOR, FIXED, COMPOSITION, 47K ±10%, 1/4W	01121	2
R2	CB4711	RESISTOR, FIXED, COMPOSITION, 470 ohms ±10%, 1/4W	01121	2
R3		(SAME AS R2)		
R4	CB1041	RESISTOR, FIXED, COMPOSITION, 100K ±10%, 1/4W	01121	1
R5	CB1031	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 1/4W	01121	29
R6		(SAME AS R5)		
R7	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	8
R8		(SAME AS R5)		
R9	CB6831	RESISTOR, FIXED, COMPOSITION, 68K ±10%, 1/4W	01121	16
R10		(SAME AS R9)		
R11		(SAME AS R5)		
R12		(SAME AS R7)		
R13		(SAME AS R5)		
R14		(SAME AS R5)		
R15		(SAME AS R7)		
R16		(SAME AS R5)		
R17		(SAME AS R9)		
R18		(SAME AS R9)		
R19		(SAME AS R5)		
R20		(SAME AS R7)		
R21		(SAME AS R5)		
R22		(SAME AS R5)		
R23		(SAME AS R7)		
R24		(SAME AS R5)		
R25		(SAME AS R9)		
R26		(SAME AS R9)		
R27		(SAME AS R5)		
R28		(SAME AS R7)		
R29		(SAME AS R5)		
R30	CB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/4W	01121	6
R31	CB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/4W	01121	17
R32		(SAME AS R5)		
R33		(SAME AS R7)		
R34		(SAME AS R5)		
R35		(SAME AS R9)		
R36		(SAME AS R9)		
R37		(SAME AS R5)		
R38		(SAME AS R7)		
R39		(SAME AS R5)		
R40 thru R46		(SAME AS R31)		
R47		(SAME AS R1)		

DECADE READOUT, CARDS A1 THROUGH A4 (Cont)
(SEE FIGURE 5-2)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R48		(SAME AS R2)		
R49		(SAME AS R2)		
R50		(SAME AS R31)		
R51		(SAME AS R5)		
R52		(SAME AS R9)		
R53		(SAME AS R5)		
R54		(SAME AS R5)		
R55 thru R57		(SAME AS R9)		
R58		(SAME AS R5)		
R59		(SAME AS R5)		
R60		(SAME AS R9)		
R61		(SAME AS R9)		
R62		(SAME AS R5)		
R63		(SAME AS R5)		
R64		(SAME AS R9)		
R65		(SAME AS R9)		
R66		(SAME AS R5)		
R67, R68	CB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/4W	01121	3
R69 thru R72		(SAME AS R30)		
R73		(SAME AS R67)		
R74		(SAME AS R30)		
R75 thru R78		(SAME AS R5)		
R79 thru R86		(SAME AS R31)		
R87 thru R104	CB1531	RESISTOR, FIXED, COMPOSITION, 15K ±10%, 1/4W	01121	18
R105	EB8211	RESISTOR, FIXED, COMPOSITION, 820 ohms ±10%, 1/2W	01121	1
R106		(SAME AS R7)		
*R107	EB5631	RESISTOR, FIXED, COMPOSITION, 56K ±10%, 1/2W	01121	1
R108	CB1051	RESISTOR, FIXED, COMPOSITION, 1Mego ±10%, 1/4W	01121	10
R109	CB2251	RESISTOR, FIXED, COMPOSITION, 2.2 Mego ±10%, 1/4W	01121	10
R110		(SAME AS R108)		
R111		(SAME AS R109)		
R112		(SAME AS R108)		
R113		(SAME AS R109)		
R114		(SAME AS R108)		
R115		(SAME AS R109)		
R116		(SAME AS R108)		
R117		(SAME AS R109)		
R118		(SAME AS R108)		
R119		(SAME AS R109)		
R120		(SAME AS R108)		
R121		(SAME AS R109)		
R122		(SAME AS R108)		
R123		(SAME AS R109)		
R124		(SAME AS R108)		
R125		(SAME AS R109)		
R126		(SAME AS R108)		
R127		(SAME AS R109)		
TB1	609-E-184	Printed Circuit Board	15356	1
-1	644-B-124	RAIL, PLASTIC	15356	2

*Use resistor with value of 39K ±10%, 1/2W when using Nixie Tube NL5961.

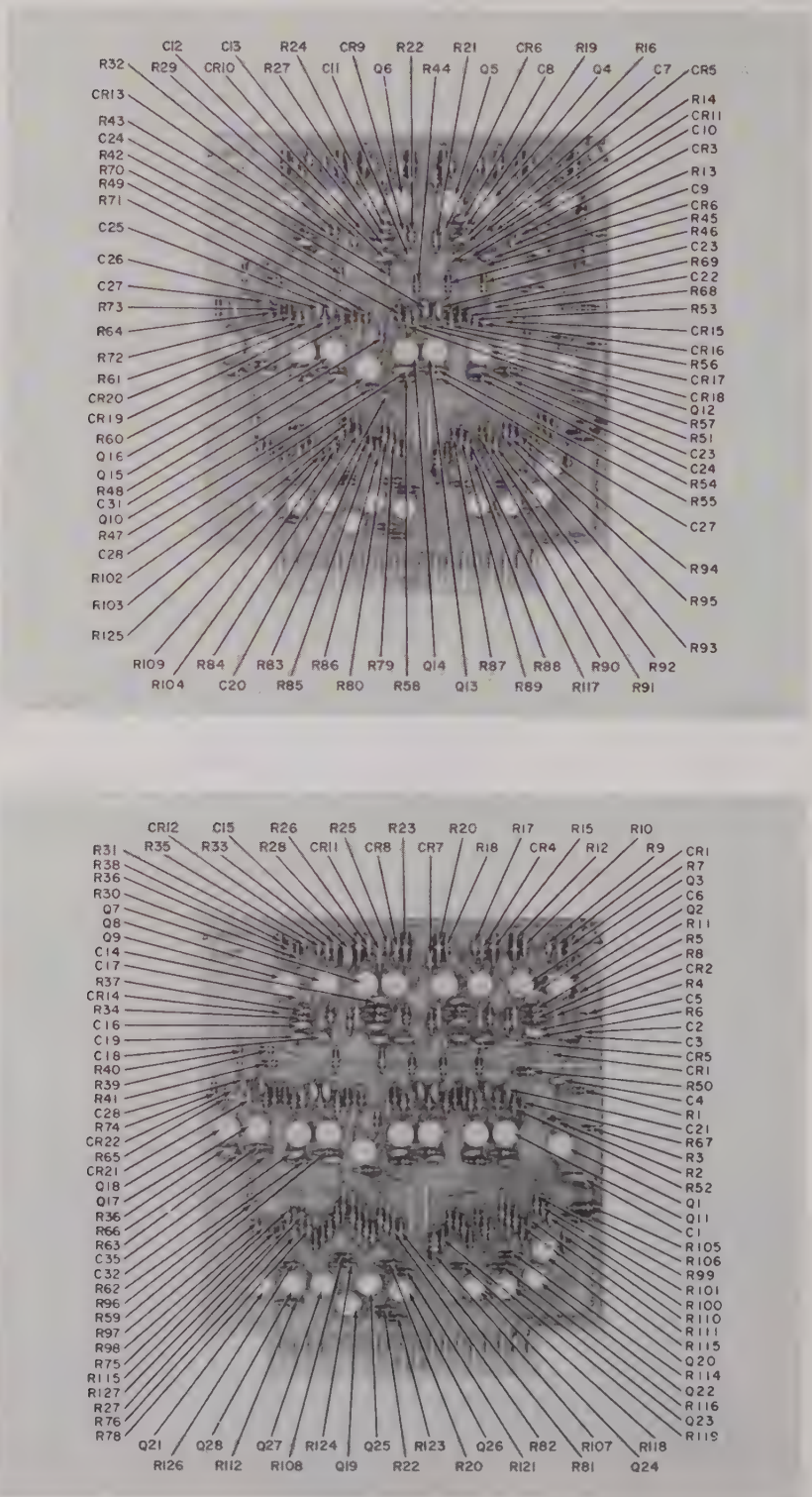


Figure 5-3. Decade Readout, Card A5

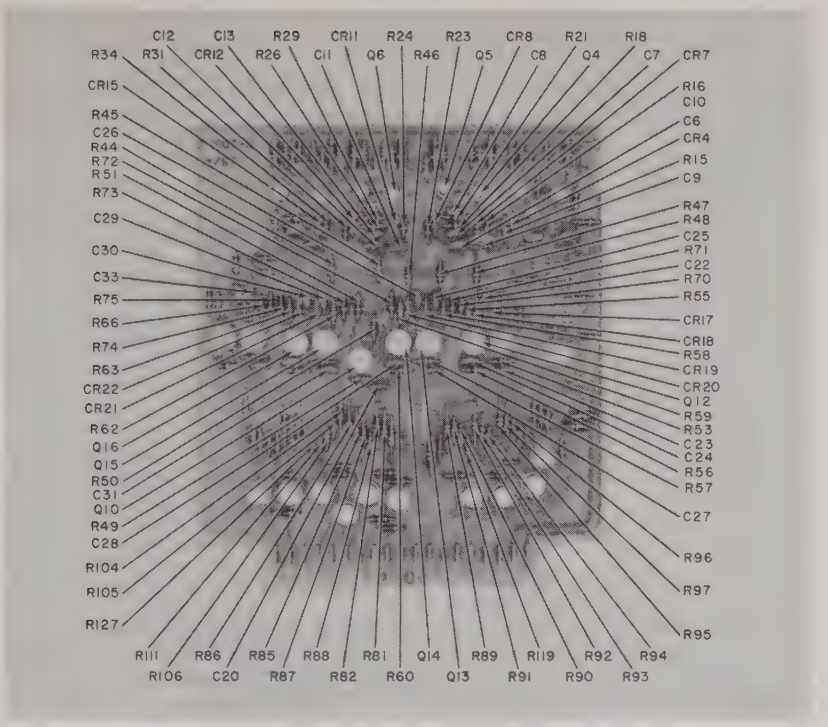
DECADE READOUT, CARD A5
(SEE FIGURE 5-3)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
CR1 thru CR26	1N191	SEMICONDUCTOR DEVICE, DIODE	05292	26
C1	.01SM-20%	CAPACITOR, FIXED, CERAMIC, 0.01 uf, ±20%, 500V	91418	1
C2	.001JF-10%	CAPACITOR, FIXED, CERAMIC, 0.001 uf, ±10%, 1KV	91418	2
C3 thru C14	220JF-10%	CAPACITOR, FIXED, CERAMIC, 220 uuf, ±10%, 1KV	91418	31
C15		(SAME AS C2)		
C16 thru C36		(SAME AS C3)		
R1	CB4731	RESISTOR, FIXED, COMPOSITION, 47K ±10%, 1/4W	01121	2
R2, R3	CB4721	RESISTOR, FIXED, COMPOSITION, 4.7K ±10%, 1/4W	01121	4
R4	CB1041	RESISTOR, FIXED, COMPOSITION, 100K ±10%, 1/4W	01121	1
R5	CB1031	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 1/4W	01121	25
R6	CB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/4W	01121	21
R7	EB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/2W	01121	7
R8		(SAME AS R5)		
R9, R10	CB6831	RESISTOR, FIXED, COMPOSITION, 68K ±10%, 1/4W	01121	16
R11		(SAME AS R5)		
R12		(SAME AS R7)		
R13, R14		(SAME AS R6)		
R14		(SAME AS R6)		
R15		(SAME AS R7)		
R16		(SAME AS R5)		
R17		(SAME AS R9)		
R18		(SAME AS R9)		
R19		(SAME AS R5)		
R20		(SAME AS R5)		
R21		(SAME AS R6)		
R22		(SAME AS R5)		
R23		(SAME AS R7)		
R24		(SAME AS R5)		
R25		(SAME AS R9)		
R26		(SAME AS R9)		
R27		(SAME AS R5)		
R28		(SAME AS R7)		
R29		(SAME AS R5)		
R30		(SAME AS R5)		
R31		(SAME AS R6)		
R32		(SAME AS R5)		
R33		(SAME AS R7)		
R34		(SAME AS R5)		
R35		(SAME AS R9)		
R36		(SAME AS R9)		
R37		(SAME AS R5)		
R38		(SAME AS R7)		
R39		(SAME AS R5)		
R40 thru R46		(SAME AS R6)		
R47		(SAME AS R1)		
R48		(SAME AS R2)		
R49		(SAME AS R2)		
R50		(SAME AS R6)		
R51		(SAME AS R5)		

DECADE READOUT, CARD A5 (Cont)
(SEE FIGURE 5-3)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R52		(SAME AS R9)		
R53		(SAME AS R9)		
R54		(SAME AS R5)		
R55		(SAME AS R5)		
R56		(SAME AS R9)		
R57		(SAME AS R9)		
R58		(SAME AS R5)		
R59		(SAME AS R5)		
R60		(SAME AS R9)		
R61		(SAME AS R9)		
R62		(SAME AS R5)		
R63		(SAME AS R5)		
R64		(SAME AS R9)		
R65		(SAME AS R9)		
R66		(SAME AS R5)		
R67, R68	CB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/4W	01121	3
R69 thru R72	CB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/4W	01121	5
R73		(SAME AS R67)		
R74		(SAME AS R69)		
R75 thru R78		(SAME AS R5)		
R79 thru R86		(SAME AS R6)		
R87 thru R104	CB1531	RESISTOR, FIXED, COMPOSITION, 15K ±10%, 1/4W	01121	18
R105	EB8211	RESISTOR, FIXED, COMPOSITION, 820 ohms ±10%, 1/2W	01121	1
R106	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	1
*R107	EB5631	RESISTOR, FIXED, COMPOSITION, 56K ±10%, 1/2W	01121	1
R108	CB1051	RESISTOR, FIXED, COMPOSITION, 1 Mego ±10%, 1/4W	01121	10
R109	CB2251	RESISTOR, FIXED, COMPOSITION, 2.2 Mego ±10%, 1/4W	01121	10
R110		(SAME AS R108)		
R111		(SAME AS R109)		
R112		(SAME AS R108)		
R113		(SAME AS R109)		
R114		(SAME AS R108)		
R115		(SAME AS R109)		
R116		(SAME AS R108)		
R117		(SAME AS R109)		
R118		(SAME AS R108)		
R119		(SAME AS R109)		
R120		(SAME AS R108)		
R121		(SAME AS R109)		
R122		(SAME AS R108)		
R123		(SAME AS R109)		
R124		(SAME AS R108)		
R125		(SAME AS R109)		
R126		(SAME AS R108)		
R127		(SAME AS R109)		
TB1	609-E-184	PRINTED CIRCUIT BOARD	15356	1
-1	644-B-124	RAIL, PLASTIC	15356	2

*Use resistor with value of 39K ±10%, 1/2W when using Nixie Tube NL5961.



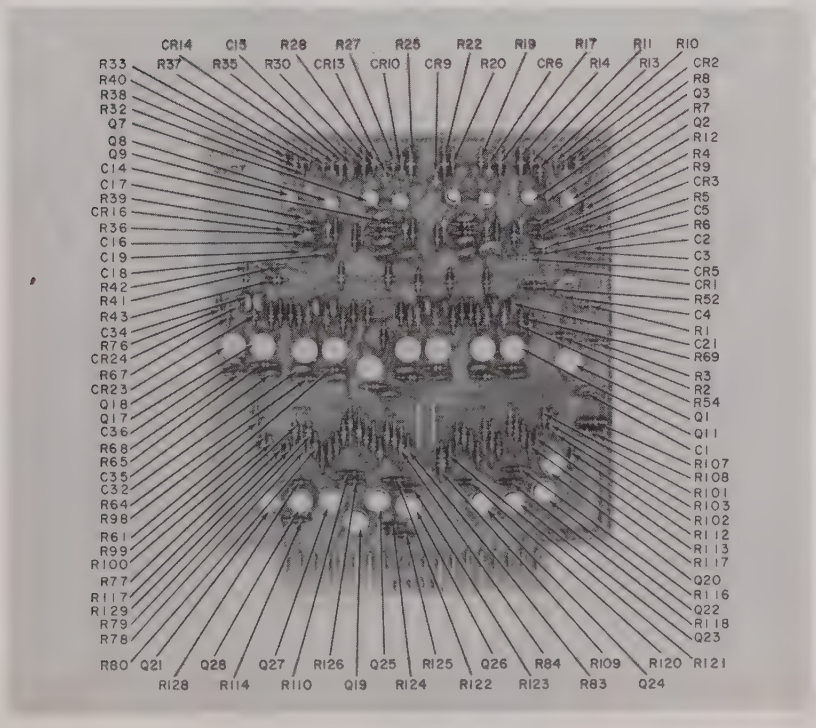


Figure 5-4. Decade Readout, Card A6

DECADE READOUT, CARD A6
(SEE FIGURE 5-4)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
CR1 thru CR16	CGD-915	SEMICONDUCTOR DEVICE, DIODE	05292	16
CR17 thru CR24	1N191	SEMICONDUCTOR DEVICE, DIODE	05292	8
C1	470JF-10%	CAPACITOR, FIXED, CERAMIC, 470 uuf, ±10%, 1KV	91418	1
C2	.001JF-10%	CAPACITOR, FIXED, CERAMIC, 0.001 uf, ±10%, 1KV	91418	1
C3, C4	33N750-10%	CAPACITOR, FIXED, CERAMIC, 33 uuf, ±10%, 1KV	91418	2
C5 thru C8	22N750-10%	CAPACITOR, FIXED, CERAMIC, 22 uuf, ±10%, 1KV	91418	8
C9 thru C12	47N750-10%	CAPACITOR, FIXED, CERAMIC, 47 uuf, ±10%, 1KV	91418	6
C13		(SAME AS C5)		
C14		(SAME AS C5)		
C15	150JP-10%	CAPACITOR, FIXED, CERAMIC, 150 uuf, ±10%, 1KV	91418	1
C16		(SAME AS C5)		
C17		(SAME AS C5)		
C18		(SAME AS C9)		
C19		(SAME AS C9)		
C20 thru C36	220JF-10%	CAPACITOR, FIXED, CERAMIC, 220 uuf, ±10%, 1KV	91418	17
Q1	2N404	TRANSISTOR, GERMANIUM, PNP	02735	10
Q2 thru Q9	Q-1031	TRANSISTOR	15356	8
Q10 thru Q18		(SAME AS Q1)		
Q19 thru Q28	Q-1002-1	TRANSISTOR	15356	10
R1	CB4731	RESISTOR, FIXED, COMPOSITION, 47K ±10%, 1/4W	01121	2
R2, R3	CB4721	RESISTOR, FIXED, COMPOSITION, 4.7K ±10%, 1/4W	01121	5
R4	CB6821	RESISTOR, FIXED, COMPOSITION, 6.8K ±10%, 1/4W	01121	1
R5 thru R7	CB1031	RESISTOR, FIXED, COMPOSITION, 10K +10%, 1/4W	01121	25
R8	EB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/2W	01121	8
R9		(SAME AS R5)		
R10, R11	CB6831	RESISTOR, FIXED, COMPOSITION, 68K ±10%, 1/4W	01121	16
R12		(SAME AS R5)		
R13		(SAME AS R5)		
R14		(SAME AS R8)		
R15		(SAME AS R5)		
R16	CB221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/4W	01121	11
R17		(SAME AS R8)		
R18		(SAME AS R5)		
R19		(SAME AS R10)		
R20		(SAME AS R10)		
R21		(SAME AS R5)		
R22		(SAME AS R8)		
R23		(SAME AS R16)		
R24		(SAME AS R16)		
R25		(SAME AS R8)		
R26		(SAME AS R5)		
R27		(SAME AS R10)		
R28		(SAME AS R10)		
R29		(SAME AS R5)		
R30		(SAME AS R8)		
R31		(SAME AS R16)		

DECADE READOUT, CARD A6 (Cont)
(SEE FIGURE 5-4)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R32	CB4711	RESISTOR, FIXED, COMPOSITION, 470 ohms ±10%, 1/4W	01121	1
R33		(SAME AS R2)		
R34		(SAME AS R16)		
R35		(SAME AS R8)		
R36		(SAME AS R5)		
R37		(SAME AS R10)		
R38		(SAME AS R10)		
R39		(SAME AS R5)		
R40		(SAME AS R8)		
R41		(SAME AS R16)		
R42 thru R48	CB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/4W	01121	16
R49		(SAME AS R1)		
R50		(SAME AS R2)		
R51		(SAME AS R2)		
R52		(SAME AS R42)		
R53		(SAME AS R5)		
R54		(SAME AS R10)		
R55		(SAME AS R10)		
R56		(SAME AS R5)		
R57		(SAME AS R5)		
R58		(SAME AS R10)		
R59		(SAME AS R10)		
R60		(SAME AS R5)		
R61		(SAME AS R5)		
R62		(SAME AS R10)		
R63		(SAME AS R10)		
R64		(SAME AS R5)		
R65		(SAME AS R5)		
R66		(SAME AS R10)		
R67		(SAME AS R10)		
R68		(SAME AS R5)		
R69, R70	CB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/4W	01121	3
R71 thru R74		(SAME AS R16)		
R75		(SAME AS R69)		
R76		(SAME AS R16)		
R77 thru R80		(SAME AS R5)		
R81 thru R88		(SAME AS R42)		
R89 thru R106	CB1531	RESISTOR, FIXED, COMPOSITION, 15K ±10%, 1/4W	01121	18
R107	EB8211	RESISTOR, FIXED, COMPOSITION, 820 ohms ±10%, 1/2W	01121	1
R108	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	1
*R109	EB5631	RESISTOR, FIXED, COMPOSITION, 56K ±10%, 1/2W	01121	1
R110	CB1051	RESISTOR, FIXED, COMPOSITION, 1 Mego ±10%, 1/4W	01121	10
R111	CB2251	RESISTOR, FIXED, COMPOSITION, 2.2 Mego ±10%, 1/4W	01121	10
R112		(SAME AS R110)		
R113		(SAME AS R111)		
R114		(SAME AS R110)		
R115		(SAME AS R111)		
R116		(SAME AS R110)		
R117		(SAME AS R111)		
R118		(SAME AS R110)		

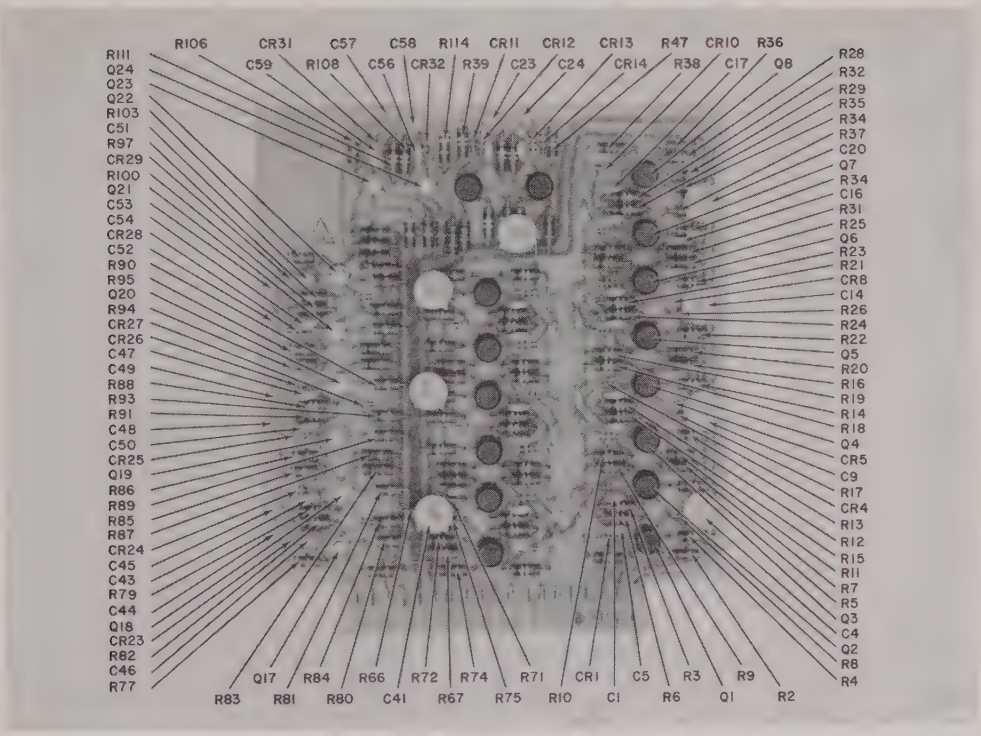
*Use resistor with value of 39K ±10%, 1/2W when using Nixie Tube NL5961.

DECADE READOUT, CARD A6 (Cont)
(SEE FIGURE 5-4)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R119		(SAME AS R111)		
R120		(SAME AS R110)		
R121		(SAME AS R111)		
R122		(SAME AS R110)		
R123		(SAME AS R111)		
R124		(SAME AS R110)		
R125		(SAME AS R111)		
R126		(SAME AS R110)		
R127		(SAME AS R111)		
R128		(SAME AS R110)		
R129		(SAME AS R111)		
TB1	609-E-184	PRINTED CIRCUIT BOARD	15356	1
-1	644-B-124	RAIL, PLASTIC	15356	2

TRIPLE DECADE, CARD A7
(SEE FIGURE 5-5)

CR1 thru CR32	1N191	SEMICONDUCTOR DEVICE, DIODE	05292	32
C1 thru C3	220JF-10%	CAPACITOR, FIXED, CERAMIC, 220 uuf, ±10%, 1KV	91418	32
C4	0.01 SM-20%	CAPACITOR, FIXED, CERAMIC, 0.01 uf, ±20%, 500V	91418	8
C5 thru C8		(SAME AS C1)		
C9		(SAME AS C4)		
C10 thru C13		(SAME AS C1)		
C14		(SAME AS C4)		
C15		(SAME AS C1)		
C16	680JL-10%	CAPACITOR, FIXED, CERAMIC, 680 uuf, ±10%, 1KV	91418	2
C17 thru C19		(SAME AS C1)		
C20		(SAME AS C4)		
C21 thru C24		(SAME AS C1)		
C25		(SAME AS C4)		
C26 thru C29		(SAME AS C1)		
C30		(SAME AS C4)		
C31 thru C34		(SAME AS C1)		
C35		(SAME AS C4)		
C36		(SAME AS C1)		
C37		(SAME AS C16)		
C38 thru C40		(SAME AS C1)		
C41		(SAME AS C4)		
C42		(SAME AS C1)		
C43	33N750-10%	CAPACITOR, FIXED, CERAMIC, 33 uuf, ±10% 1KV	91418	8
C44, C45	47N750-10%	CAPACITOR° FIXED, CERAMIC, 47 uuf, ±10% 1KV	91418	8
C46		(SAME AS C43)		
C47		(SAME AS C43)		
C48		(SAME AS C44)		
C49		(SAME AS C44)		
C50		(SAME AS C43)		
C51		(SAME AS C43)		
C52		(SAME AS C44)		
C53		(SAME AS C44)		
C54		(SAME AS C43)		
C55	150JP-10%	CAPACITOR, FIXED, CERAMIC, 150 uuf, ±10%, 1KV	91418	1



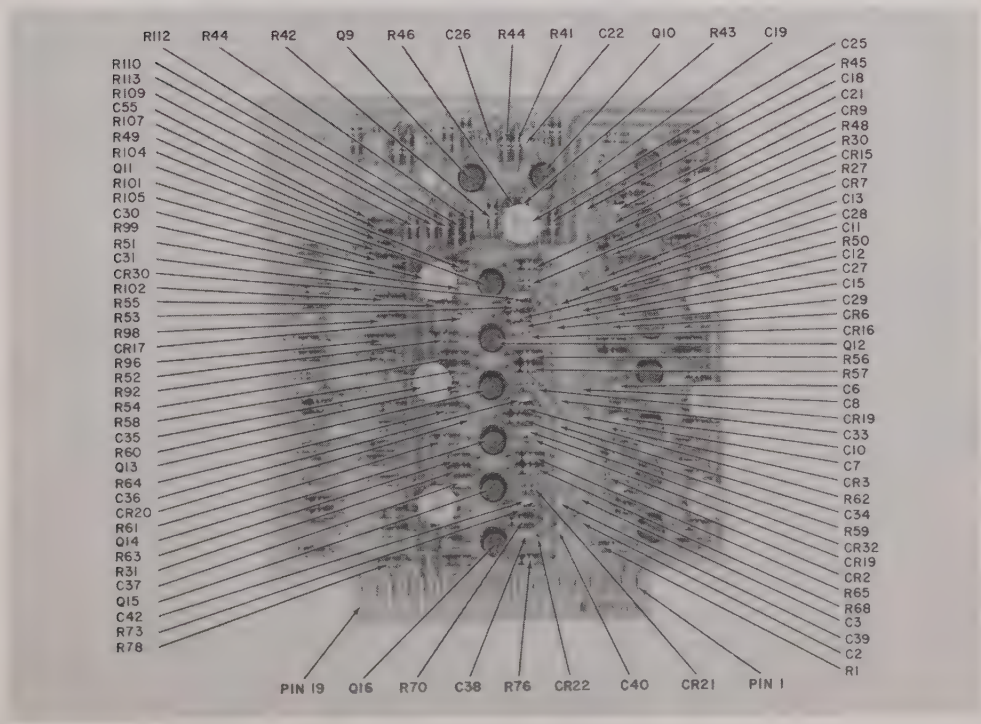


Figure 5-5. Triple Decade, Card A7

TRIPLE DECADE, CARD A7 (Cont)
(SEE FIGURE 5-5)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
C56		(SAME AS C43)		
C57		(SAME AS C44)		
C58		(SAME AS C44)		
C59		(SAME AS C43)		
Q1 thru Q16	Q-1001	TRANSISTOR	15356	16
Q17 thru Q24	Q-1031	TRANSISTOR	15356	8
R1	EB1031	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 1/2W	01121	58
R2	EB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/2W	01121	24
R3 thru R6		(SAME AS R1)		
R7		(SAME AS R2)		
R8	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	8
R9		(SAME AS R1)		
R10		(SAME AS R1)		
R11		(SAME AS R2)		
R12 thru R15		(SAME AS R1)		
R16		(SAME AS R2)		
R17		(SAME AS R8)		
R18		(SAME AS R1)		
R19		(SAME AS R1)		
R20		(SAME AS R2)		
R21 thru R24		(SAME AS R1)		
R25		(SAME AS R2)		
R26		(SAME AS R8)		
R27		(SAME AS R1)		
R28	EB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/2W	01121	2
R29		(SAME AS R1)		
R30		(SAME AS R1)		
R31		(SAME AS R2)		
R32 thru R35		(SAME AS R1)		
R36		(SAME AS R2)		
R37		(SAME AS R8)		
R38		(SAME AS R1)		
R39		(SAME AS R1)		
R40		(SAME AS R2)		
R41 thru R44		(SAME AS R1)		
R45		(SAME AS R2)		
R46		(SAME AS R8)		
R47		(SAME AS R1)		
R48		(SAME AS R1)		
R49		(SAME AS R2)		
R50 thru R53		(SAME AS R1)		
R54		(SAME AS R2)		
R55		(SAME AS R8)		
R56		(SAME AS R1)		
R57		(SAME AS R1)		
R58		(SAME AS R2)		
R59 thru R62		(SAME AS R1)		
R63		(SAME AS R2)		
R64		(SAME AS R8)		
R65		(SAME AS R1)		
R66		(SAME AS R28)		
R67		(SAME AS R1)		
R68		(SAME AS R1)		
R69		(SAME AS R2)		
R70 thru R73		(SAME AS R1)		

TRIPLE DECADE, CARD A7 (Cont)
(SEE FIGURE 5-5)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R74		(SAME AS R2)		
R75		(SAME AS R8)		
R76		(SAME AS R1)		
R77	EB3321	RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, 1/2W	01121	8
R78		(SAME AS R2)		
R79		(SAME AS R1)		
R80, R81	EB4721	RESISTOR, FIXED, COMPOSITION, 4.7K ±10%, 1/2W	01121	9
R82		(SAME AS R1)		
R83		(SAME AS R2)		
R84	EB1011	RESISTOR, FIXED, COMPOSITION, 100 ohms ±10%, 1/2W	01121	4
R85		(SAME AS R77)		
R86		(SAME AS R77)		
R87		(SAME AS R2)		
R88		(SAME AS R1)		
R89		(SAME AS R80)		
R90		(SAME AS R80)		
R91		(SAME AS R1)		
R92		(SAME AS R2)		
R93		(SAME AS R84)		
R94		(SAME AS R77)		
R95		(SAME AS R77)		
R96		(SAME AS R2)		
R97		(SAME AS R1)		
R98		(SAME AS R80)		
R99		(SAME AS R80)		
R100		(SAME AS R1)		
R101		(SAME AS R2)		
R102		(SAME AS R84)		
R103		(SAME AS R77)		
R104	EB1531	RESISTOR, FIXED, COMPOSITION, 15K ±10%, 1/2W	01121	1
R105		(SAME AS R80)		
R106		(SAME AS R77)		
R107		(SAME AS R2)		
R108		(SAME AS R1)		
R109		(SAME AS R80)		
R110		(SAME AS R80)		
R111		(SAME AS R1)		
R112		(SAME AS R2)		
R113		(SAME AS R84)		
R114		(SAME AS R77)		
TB1	620-D-150	PRINTED CIRCUIT BOARD	15356	1
-1	644-B-126	RAIL, PLASTIC	15356	2

TRIPLE DECADE, CARD A8
(SEE FIGURE 5-6)

CR1 thru CR30	1N191	SEMICONDUCTOR DEVICE, DIODE	05292	30
C1 thru C3	DM-10-221J	CAPACITOR, FIXED, MICA, 220 uuf, ±5%, 500V	72136	48
C4	.01SM-20%	CAPACITOR, FIXED, CERAMIC, 0.01 uf, ±20%, 500V	91418	12
C5 thru C8		(SAME AS C1)		
C9		(SAME AS C4)		

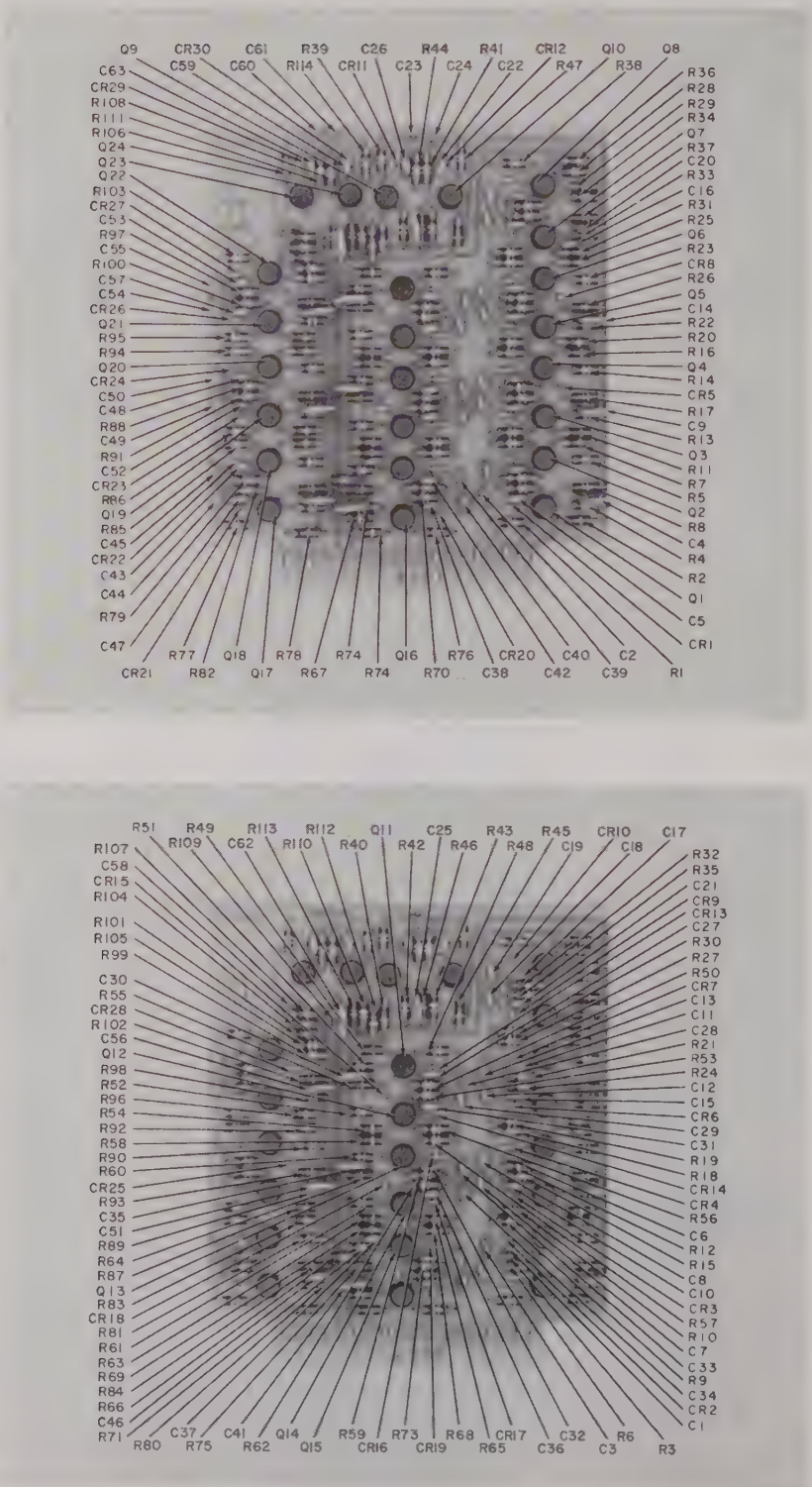


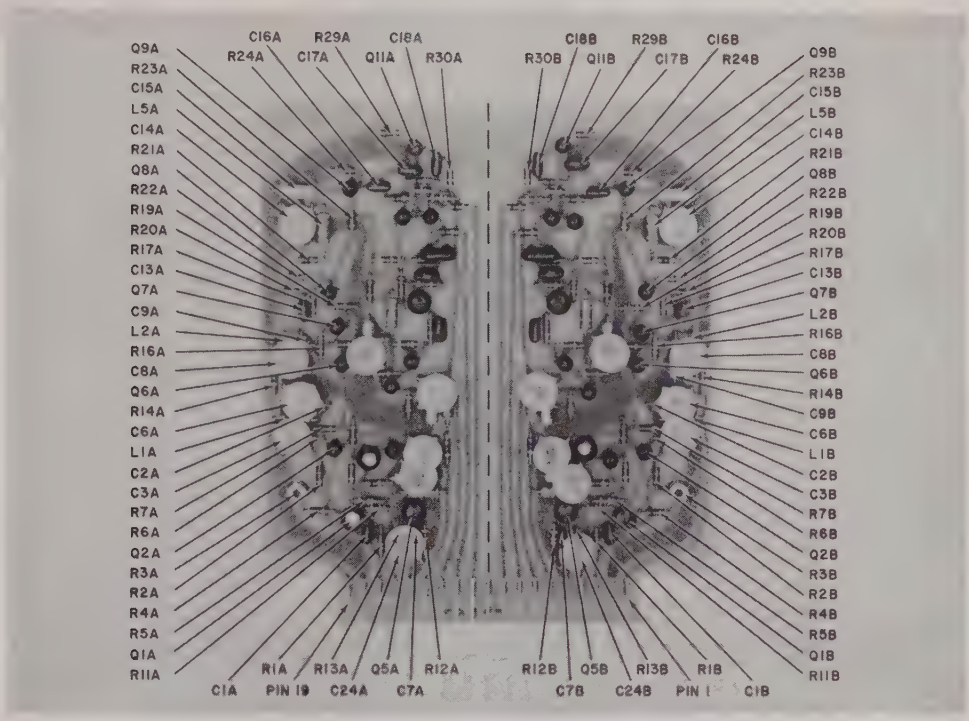
Figure 5-6. Triple Decade, Card A8

TRIPLE DECADE, CARD A8 (Cont)
(SEE FIGURE 5-6)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
C10 thru C13		(SAME AS C1)		
C14		(SAME AS C4)		
C15		(SAME AS C1)		
C16	680JL-10%	CAPACITOR, FIXED, CERAMIC, 680 uuf, ±10%, 1KV	91418	3
C17 thru C19		(SAME AS C1)		
C20		(SAME AS C4)		
C21 thru C24		(SAME AS C1)		
C25		(SAME AS C4)		
C26 thru C29		(SAME AS C1)		
C30		(SAME AS C4)		
C31 thru C34		(SAME AS C1)		
C35		(SAME AS C4)		
C36		(SAME AS C1)		
C37		(SAME AS C16)		
C38 thru C40		(SAME AS C1)		
C41		(SAME AS C4)		
C42 thru C45		(SAME AS C1)		
C46		(SAME AS C4)		
C47 thru C50		(SAME AS C1)		
C51		(SAME AS C4)		
C52 thru C55		(SAME AS C1)		
C56		(SAME AS C4)		
C57		(SAME AS C1)		
C58		(SAME AS C16)		
C59 thru C61		(SAME AS C1)		
C62		(SAME AS C4)		
C63		(SAME AS C1)		
Q1 thru Q24	Q-1001	TRANSISTOR	15356	24
R1	EB1031	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 1/2W	01121	75
R2	EB1021	RESISTOR, FIXED, COMPOSITION, 1K ± 10%, 1/2W	01121	24
R3 thru R6		(SAME AS R1)		
R7		(SAME AS R2)		
R8	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	12
R9		(SAME AS R1)		
R10		(SAME AS R1)		
R11		(SAME AS R2)		
R12 thru R15		(SAME AS R1)		
R16		(SAME AS R2)		
R17		(SAME AS R8)		
R18		(SAME AS R1)		
R19		(SAME AS R1)		
R20		(SAME AS R2)		
R21 thru R24		(SAME AS R1)		
R25		(SAME AS R2)		
R26		(SAME AS R8)		
R27		(SAME AS R1)		
R28	EB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/2W	01121	3
R29		(SAME AS R1)		
R30		(SAME AS R1)		
R31		(SAME AS R2)		
R32 thru R35		(SAME AS R1)		
R36		(SAME AS R2)		
R37		(SAME AS R8)		
R38		(SAME AS R1)		
R39		(SAME AS R1)		

TRIPLE DECADE, CARD A8 (Cont)
(SEE FIGURE 5-6)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R40		(SAME AS R2)		
R41 thru R44		(SAME AS R1)		
R45		(SAME AS R2)		
R46		(SAME AS R8)		
R47		(SAME AS R1)		
R48		(SAME AS R1)		
R49		(SAME AS R2)		
R50 thru R53		(SAME AS R1)		
R54		(SAME AS R2)		
R55		(SAME AS R8)		
R56		(SAME AS R1)		
R57		(SAME AS R1)		
R58		(SAME AS R2)		
R59 thru R62		(SAME AS R1)		
R63		(SAME AS R2)		
R64		(SAME AS R8)		
R65		(SAME AS R1)		
R66		(SAME AS R28)		
R67		(SAME AS R1)		
R68		(SAME AS R1)		
R69		(SAME AS R2)		
R70 thru R73		(SAME AS R1)		
R74		(SAME AS R2)		
R75		(SAME AS R8)		
R76		(SAME AS R1)		
R77		(SAME AS R1)		
R78		(SAME AS R2)		
R79 thru R82		(SAME AS R1)		
R83		(SAME AS R2)		
R84		(SAME AS R8)		
R85		(SAME AS R1)		
R86		(SAME AS R1)		
R87		(SAME AS R2)		
R88 thru R91		(SAME AS R1)		
R92		(SAME AS R2)		
R93		(SAME AS R8)		
R94		(SAME AS R1)		
R95		(SAME AS R1)		
R96		(SAME AS R2)		
R97 thru R100		(SAME AS R1)		
R101		(SAME AS R2)		
R102		(SAME AS R8)		
R103		(SAME AS R1)		
R104		(SAME AS R28)		
R105		(SAME AS R1)		
R106		(SAME AS R1)		
R107		(SAME AS R2)		
R108 thru R111		(SAME AS R1)		
R112		(SAME AS R2)		
R113		(SAME AS R8)		
R114		(SAME AS R1)		
TB1	620-D-150	PRINTED CIRCUIT BOARD	15356	1
-1	644-B-126	RAIL, PLASTIC	15356	2



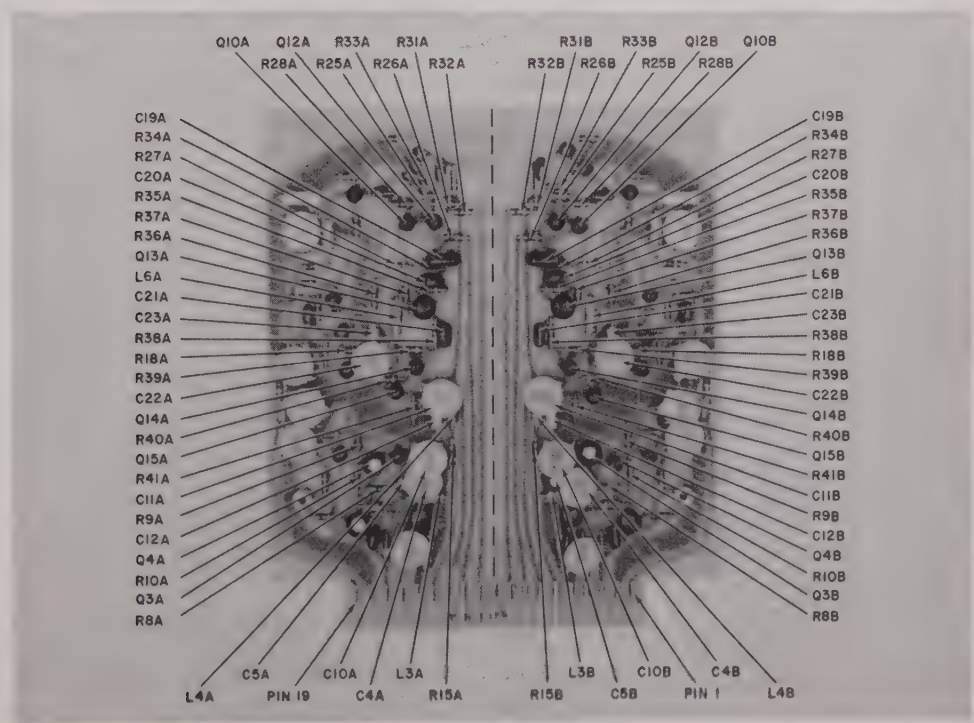


Figure 5-7. Channel A and B Amplifier, Card A9

CHANNEL A AND B AMPLIFIER, CARD A9
(SEE FIGURE 5-7)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
CR1 thru CR26	1N191	SEMICONDUCTOR, DEVICE, DIODE	05292	26
C1A, C1B	DM-10-050J	CAPACITOR, FIXED, MICA, 5 uuf, ±5%, 500V	72136	2
C2A, C2B	150D186X9015B2	CAPACITOR, FIXED, ELECTROLYTIC, 18 uf, ±10%, 15V	56289	2
C3A thru C4B	.01SM-20%	CAPACITOR, FIXED, CERAMIC, 0.01 uf, ±20%, 500V	91418	18
C5A, C5B		(SAME AS C2A)		
C6A, C6B		(SAME AS C3A)		
C7A, C7B	DM-10-100J	CAPACITOR, FIXED, MICA, 10 uuf, ±5%, 500V	72136	4
C8A, C8B		(SAME AS C3A)		
C9A, C9B		(SAME AS C2A)		
C10A, C10B		(SAME AS C3A)		
C11A, C11B		(SAME AS C3A)		
C12A, C12B		(SAME AS C2A)		
C13A, C13B	DM-10-560J	CAPACITOR, FIXED, MICA, 56 uuf, ±5%, 500V	72136	2
C14A, C14B		(SAME AS C3A)		
C15A, C15B		(SAME AS C2A)		
C16A thru C17B	DM-10-680J	CAPACITOR, FIXED, MICA, 68 uuf, ±5%, 500V	72136	4
C18A, C18B		(SAME AS C7A)		
C19A, C19B	DM-10-102J	CAPACITOR, FIXED, MICA, 1000 uuf, 5%, 500V	72136	2
C20A, C20B	220JF-10%	CAPACITOR, FIXED, CERAMIC, 220 uuf, ±10%, 1KV	91418	2
C21A, C21B	47N750-10%	CAPACITOR, FIXED, CERAMIC, 47 uuf, ±10%, 1KV	91418	2
C22A, C22B		(SAME AS C3A)		
C23A, C23B		(SAME AS C2A)		
C24A, C24B		(SAME AS C3A)		
L1A thru L6B	MS18130-14	COIL, Radio Frequency	96906	12
Q1A thru Q2B	2N3638	TRANSISTOR	07263	8
Q3A, Q3B	2N3640	TRANSISTOR	07263	18
Q4A, Q4B		(SAME AS Q1A)		
Q5A thru Q10B		(SAME AS Q3A)		
Q11A, Q11B	2N3646	TRANSISTOR	07263	4
Q12A, Q12B		(SAME AS Q3A)		
Q13A, Q13B		(SAME AS Q1A)		
Q14A, Q14B		(SAME AS Q11A)		
Q15A, Q15B		(SAME AS Q3A)		
R1A, R1B	CB6841	RESISTOR, FIXED, COMPOSITION, 680K ±10%, 1/4W	01121	2
R2A, R2B	CB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/4W	01121	8
R3A, R3B	3307P-1-202	RESISTOR, ADJUSTABLE	80294	2
R4A, R4B	CB1051	RESISTOR, FIXED, COMPOSITION, 1 Mego ±10%, 1/4W	01121	2
R5A, R5B	CB4731	RESISTOR, FIXED, COMPOSITION, 47K ±10%, 1/4W	01121	8
R6A thru R7B		(SAME AS R2A)		
R8A, R8B	CB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/4W	01121	12
R9A thru R10B	CB1521	RESISTOR, FIXED, COMPOSITION, 1.5K ±10%, 1/4W	01121	6
R11A, R11B		(SAME AS R5A)		
R12A, R12B	CB4711	RESISTOR, FIXED, COMPOSITION, 470 ohms ±10%, 1/4W	01121	18

CHANNEL A AND B AMPLIFIER, CARD A9 (Cont)
(SEE FIGURE 5-7)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R13A, R13B	CB3311	RESISTOR, FIXED, COMPOSITION, 330 ohms ±10%, 1/4W	01121	2
R14A thru R15B	CB1001	RESISTOR, FIXED, COMPOSITION, 10 ohms ±10%, 1/4W	01121	8
R16A, R16B	CB6811	RESISTOR, FIXED, COMPOSITION, 680 ohms ±10%, 1/4W	01121	6
R17A, R17B		(SAME AS R8A)		
R18A, R18B		(SAME AS R12A)		
R19A, R19B		(SAME AS R13A)		
R20A, R20B		(SAME AS R9A)		
R21A, R21B		(SAME AS R14A)		
R22A, R22B		(SAME AS R12A)		
R23A, R23B	CB1011	RESISTOR, FIXED, COMPOSITION, 100 ohms ±10%, 1/4W	01121	2
R24A, R24B		(SAME AS R12A)		
R25A, R25B		(SAME AS R5A)		
R26A, R26B		(SAME AS R8A)		
R27A, R27B		(SAME AS R12A)		
R28A, R28B		(SAME AS R8A)		
R29A, R29B		(SAME AS R2A)		
R30A, R30B		(SAME AS R16A)		
R31A, R31B		(SAME AS R5A)		
R32A thru R33B		(SAME AS R8A)		
R34A, R34B	CB1821	RESISTOR, FIXED, COMPOSITION, 1.8K ±10%, 1/4W	01121	4
R35A, R35B		(SAME AS R12A)		
R36A, R36B		(SAME AS R14A)		
R37A, R37B		(SAME AS R16A)		
R38A, R38B		(SAME AS R34A)		
R39A thru R41B		(SAME AS R12A)		
TB1	644-E-100	PRINTED CIRCUIT BOARD	15356	1
-1	644-B-127	RAIL, PLASTIC	15356	2

GATING LOGIC, CARD A10
(SEE FIGURE 5-8)

CR1 thru CR3	1N191	SEMICONDUCTOR DEVICE, DIODE	05292	19
CR4		(NOT USED)		
CR5 thru CR14		(SAME AS CR1)		
CR17 thru CR22		(SAME AS CR1)		
CR23		(NOT USED)		
C1	100N1500-10%	CAPACITOR, FIXED, CERAMIC, 100 uuf, ±10%, 1KV	91418	2
C2	220JF-10%	CAPACITOR, FIXED, CERAMIC, 220 uuf, ±10%, 1KV	91418	10
C3	47N750-10%	CAPACITOR, FIXED, CERAMIC, 47 uuf, ±10%, 1KV	91418	1
C4, C5	33N750-10%	CAPACITOR, FIXED, CERAMIC, 33 uuf, ±10%, 1KV	91418	2
C7 thru C10		(SAME AS C2)		
C11	.01SM-20%	CAPACITOR, FIXED, CERAMIC, 0.01 uf, ±20%, 500V	91418	5
C12		(SAME AS C2)		
C13	150D276X9015R2	CAPACITOR, FIXED, ELECTROLYTIC, 27 uf, 15V	56289	1
C14	.001JF-10%	CAPACITOR, FIXED, CERAMIC, 0.991 uf, ±10%, 1KV	91418	3

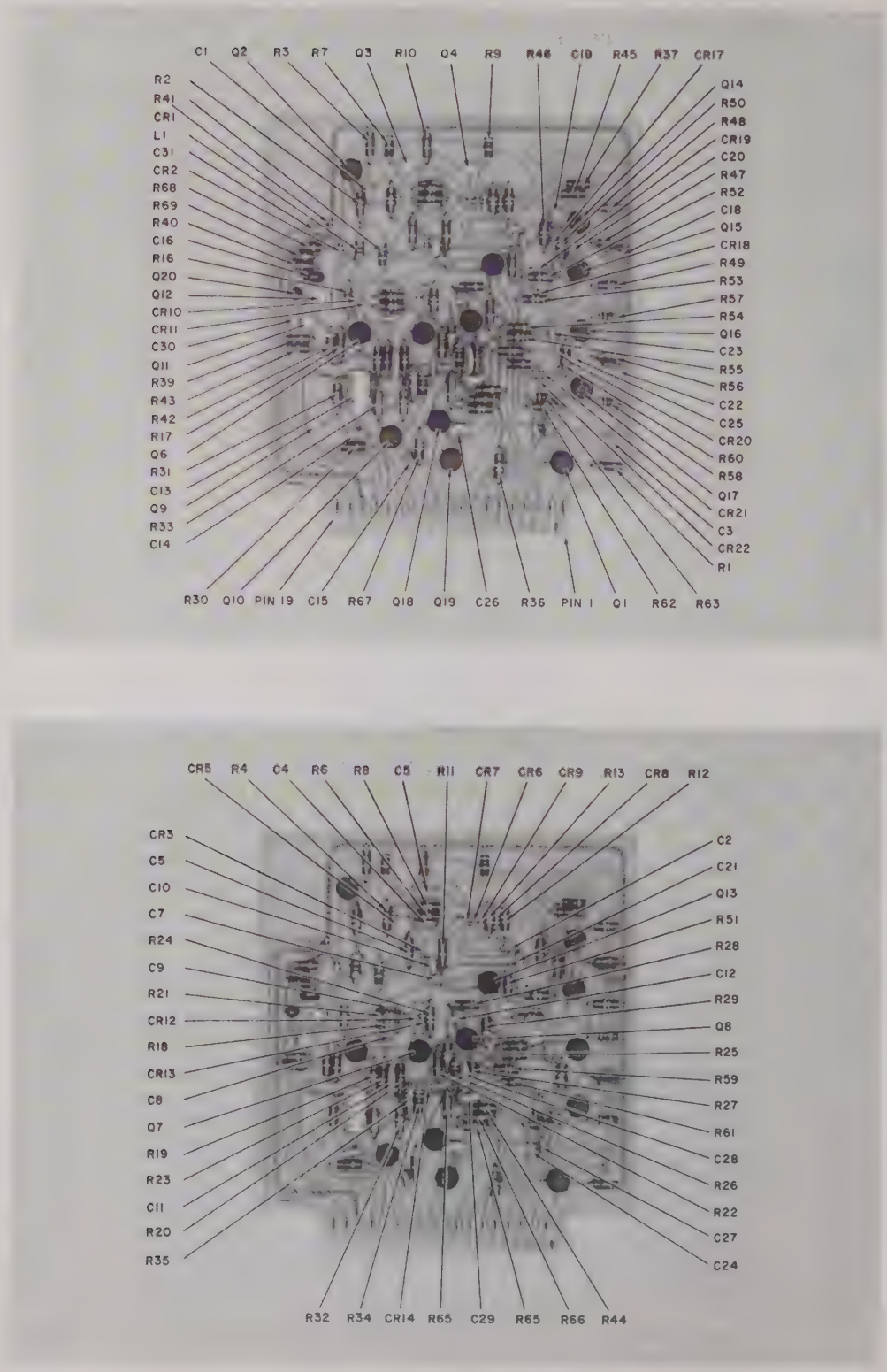


Figure 5-8. Gating Logic, Card A10

GATING LOGIC, CARD A10 (Cont)
(SEE FIGURE 5-8)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
C15		(SAME AS C2)		
C16	330JF-10%	CAPACITOR, FIXED, CERAMIC, 330 uuf, ±10%, 1KV	91418	1
C18		(SAME AS C11)		
C19	.002B-20%	CAPACITOR, FIXED, CERAMIC, 0.002 uf, ±20%, 1KV	91418	2
C20		(SAME AS C2)		
C21		(SAME AS C2)		
C22		(SAME AS C11)		
C23		(SAME AS C19)		
C24		(SAME AS C2)		
C25		(SAME AS C14)		
C26		(SAME AS C14)		
C27	470JF-10%	CAPACITOR, FIXED, CERAMIC, 470 uuf, ±10%, 1KV	91418	1
C28		(SAME AS C11)		
C29	.1JF-10%	CAPACITOR, FIXED, CERAMIC, 0.1 uf, ±10%, 1KV	91418	1
C30		(SAME AS C1)		
C31		(SAME AS C11)		
L1	MS18130-21	CHOKE, Radio frequency	96906	1
Q1	Q-1001	TRANSISTOR	15356	13
Q2	700-B-02	TRANSISTOR	15356	1
Q3, Q4	Q-1031	TRANSISTOR	15356	4
Q4 thru Q8		(SAME AS Q1)		
Q9	2N2646	TRANSISTOR	03508	1
Q10		(SAME AS Q1)		
Q11		(SAME AS Q3)		
Q12		(SAME AS Q3)		
Q13 thru Q19		(SAME AS Q1)		
Q20	2N3646	TRANSISTOR	07263	1
R1	EB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/2W	01121	17
R2	EB1031	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 1/2W	01121	22
R3		(SAME AS R1)		
R4		(SAME AS R2)		
R5		(SAME AS R1)		
R6		(SAME AS R2)		
R7	EB4721	RESISTOR, FIXED, COMPOSITION, 4.7K ±10%, 1/2W	01121	9
R8		(SAME AS R2)		
R9		(SAME AS R7)		
R10	EB1011	RESISTOR, FIXED, COMPOSITION, 100 ohms ±10%, 1/2W	01121	4
R11		(SAME AS R1)		
R12		(SAME AS R2)		
R13		(SAME AS R2)		
R14, R15	EB4711	RESISTOR, FIXED, COMPOSITION, 470 ohms ±10%, 1/2W	01121	5
R16		(SAME AS R2)		
R17		(SAME AS R1)		
R18 thru R21		(SAME AS R2)		
R22		(SAME AS R1)		
R23		(SAME AS R10)		
R24		(SAME AS R2)		
R25		(SAME AS R2)		
R26		(SAME AS R7)		
R27		(SAME AS R10)		

GATING LOGIC, CARD A10 (Cont)
(SEE FIGURE 5-8)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R28		(SAME AS R1)		
R29	EB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/2W	01121	2
R30	EB2721	RESISTOR, FIXED, COMPOSITION, 2.7K ±10%, 1/2W	01121	1
R31		(SAME AS R1)		
R32		(SAME AS R2)		
R33	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	2
R34		(SAME AS R7)		
R35	EB3321	RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, 1/2W	01121	1
R36		(SAME AS R2)		
R37	EB1051	RESISTOR, FIXED, COMPOSITION, 1 Mego ±10%, 1/2W	01121	1
R39		(SAME AS R1)		
R40		(SAME AS R14)		
R41		(SAME AS R7)		
R42		(SAME AS R14)		
R43	EB6811	RESISTOR, FIXED, COMPOSITION, 680 ohms ±10%, 1/2W	01121	1
R44		(SAME AS R1)		
R45		(SAME AS R1)		
R46	EB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/2W	01121	2
R47		(SAME AS R33)		
R48, R49	EB1531	RESISTOR, FIXED, COMPOSITION, 15K ±10%, 1/2W	01121	2
R50		(SAME AS R2)		
R51		(SAME AS R1)		
R52		(SAME AS R2)		
R53		(SAME AS R2)		
R54		(SAME AS R1)		
R55		(SAME AS R2)		
R56		(SAME AS R10)		
R57		(SAME AS R7)		
R58		(SAME AS R7)		
R59		(SAME AS R46)		
R60		(SAME AS R2)		
R61		(SAME AS R1)		
R62		(SAME AS R2)		
R63		(SAME AS R7)		
R64		(SAME AS R29)		
R65		(SAME AS R2)		
R66		(SAME AS R1)		
R67		(SAME AS R14)		
R68		(SAME AS R1)		
R69		(SAME AS R1)		
TB1	644-E-107	PRINTED CIRCUIT BOARD	15356	1
-1	644-B-125	RAIL, PLASTIC	15356	2

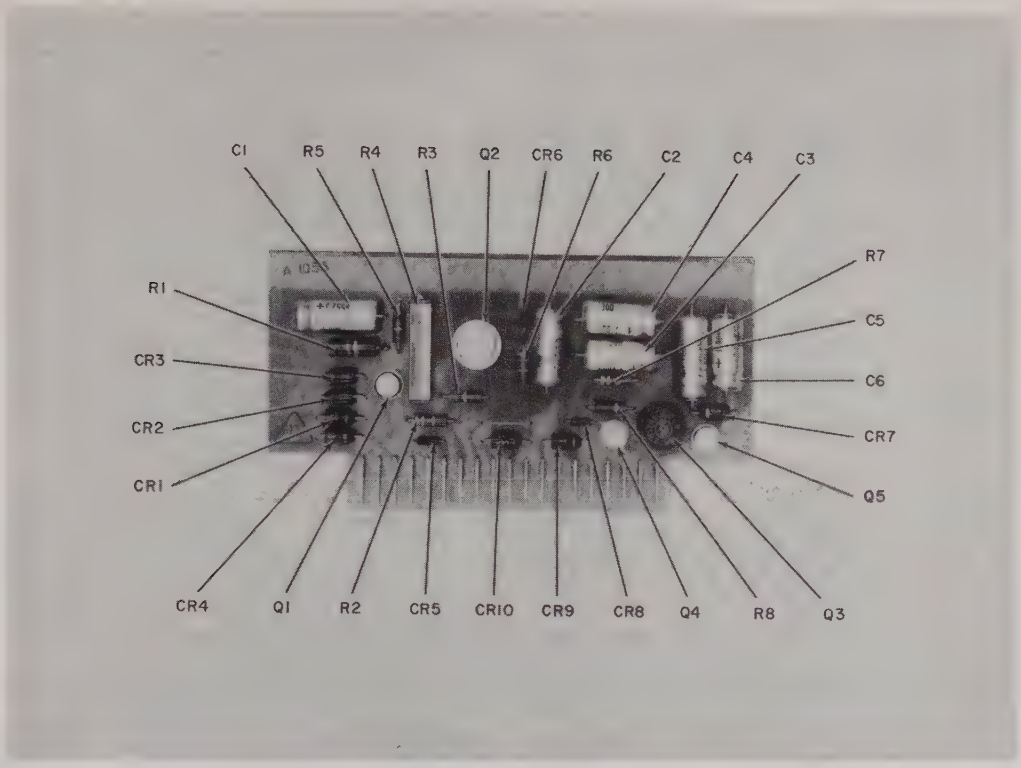


Figure 5-9. Power Supply, Card A11

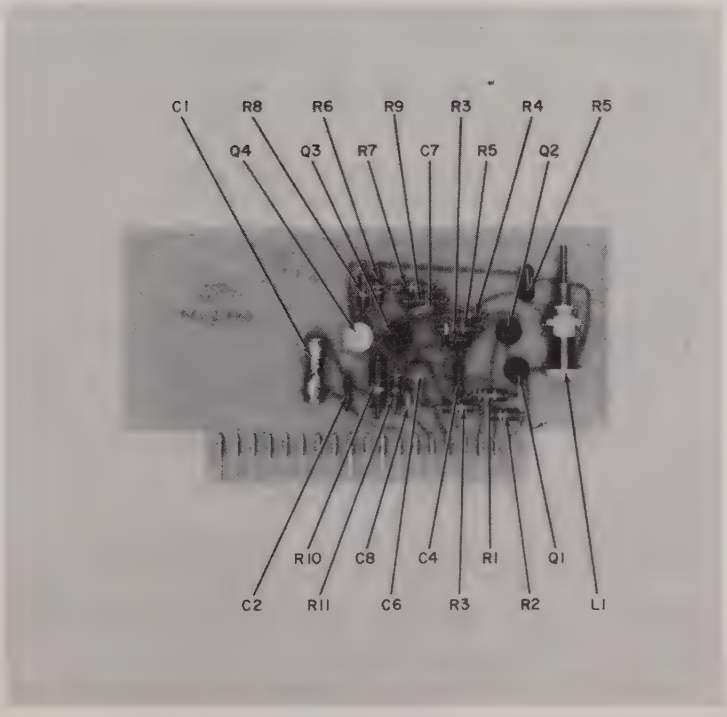


Figure 5-10. Oscillator, Card A12

POWER SUPPLY, CARD A11
(SEE FIGURE 5-9)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
CR1 thru CR4	2A50	SEMICONDUCTOR DEVICE, DIODE	13327	4
CR5	1N752	SEMICONDUCTOR DEVICE, DIODE	12954	1
CR6	1N712A	SEMICONDUCTOR DEVICE, DIODE	12954	1
CR7	1R15	SEMICONDUCTOR DEVICE, DIODE	13327	1
CR8	1N714	SEMICONDUCTOR DEVICE, DIODE	12954	1
CR9	CER-67	SEMICONDUCTOR DEVICE, DIODE	13327	1
CR10	CER-72	SEMICONDUCTOR DEVICE, DIODE	13327	1
C1	TE-1211	CAPACITOR, FIXED, ELECTROLYTIC, 100 uf, 25V	56289	2
C2 thru C4	TE-1162	CAPACITOR, FIXED, ELECTROLYTIC, 100 uf, 15V	56289	4
C5		(SAME AS C1)		
C6		(SAME AS C2)		
Q1	2N1008	TRANSISTOR	02735	1
Q2	2N11R3A	TRANSISTOR	02735	1
Q3	2N1701	TRANSISTOR	02735	1
Q4, Q5	Q-1002-1	TRANSISTOR	15356	2
R1	GB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1W	01121	1
R2	EB3311	RESISTOR, FIXED, COMPOSITION, 330 ohms ±10%, 1/2W	01121	1
R3	EB6801	RESISTOR, FIXED, COMPOSITION, 68 ohms ±10%, 1/2W	01121	1
R4	260P-1-500	RESISTOR, VARIABLE, 1W	80294	1
R5	EB1011	RESISTOR, FIXED, COMPOSITION, 100 ohms ±10%, 1/2W	01121	1
R6	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	1
R7	EB3321	RESISTOR, FIXED, COMPOSITION, 3.3K ±10%, 1/2W	01121	1
R8	EB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/2W	01121	1
TB1	644-D-110	PRINTED CIRCUIT BOARD	15356	1

OSCILLATOR, CARD A12
(SEE FIGURE 5-10)

C1	VCJ-1159	CAPACITOR, VARIABLE	73899	1
C2	DM-15-150J	CAPACITOR, FIXED, MICA, 15 uuf, ±5%, 100V	72136	1
C3	DM-15-102J	CAPACITOR, FIXED, MICA, 1000 uuf, ±5% 100V	72136	2
C4	DM-10-101J	CAPACITOR, FIXED, MICA, 100 uuf ±5% 500V	72136	1
C5		(SAME AS C3)		
C6 thru C8	.001JF-10%	CAPACITOR, FIXED, CERAMIC, 0.001 uf, ±10%, 1KV	91418	3
L1	404-11	CHOKE, VARIABLE	04213	1
Q1, Q2	2N3638	TRANSISTOR	07263	2
Q3, Q4	Q-1001	TRANSISTOR	15356	2
R1	EB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/2W	01121	2
R2	EB3311	RESISTOR, FIXED, COMPOSITION, 330 ohms ±10%, 1/2W	01121	1
R3		(SAME AS R1)		
R4	EB4721	RESISTOR, FIXED, COMPOSITION, 4.7K ±10%, 1/2W	01121	1

OSCILLATOR, CARD A12 (Cont)
(SEE FIGURE 5-10)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R5	EB2221	RESISTOR, FIXED, COMPOSITION, 2.2K ±10%, 1/2W	01121	1
R6	EB1041	RESISTOR, FIXED, COMPOSITION, 100K ±10%, 1/2W	01121	1
R7	EB1031	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 1/2W	01121	1
R8	EB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/2W	01121	1
R9	EB1011	RESISTOR, FIXED, COMPOSITION, 100 ohms, ±10%, 1/2W	01121	1
R10	EB2211	RESISTOR, FIXED, COMPOSITION, 200 ohms, ±10%, 1/2W	01121	1
R11	EB4701	RESISTOR, FIXED, COMPOSITION, 47 ohms, ±10%, 1/2W	01121	1
TB1	644-0-134	PRINTED CIRCUIT BOARD	15356	1

SINGLE DECADE, CARD A13
(SEE FIGURE 5-11)

CR1, CR2		(NOT USED)		
CR3 thru CR16	1N191	SEMICONDUCTOR DEVICE, DIODE		14
C6, C7	.01SM-20%	CAPACITOR, FIXED, CERAMIC, 0.01 uf, ±20%, 500V	91418	6
C8 thru C11	220JF-10%	CAPACITOR, FIXED, CERAMIC, 220 uuf, ±10%, 1KV	91418	16
C12		(SAME AS C6)		
C13 thru C16		(SAME AS C8)		
C17		(SAME AS C6)		
C18 thru C21		(SAME AS C8)		
C22		(SAME AS C6)		
C23	680JL-10%	CAPACITOR, FIXED, CERAMIC, 680 uuf, ±10%, 1KV	91418	1
C24 thru C27		(SAME AS C8)		
C28		(SAME AS C6)		
Q7 thru Q15	Q-1001	TRANSISTOR	15356	9
R14, R15	EB4721	RESISTOR, FIXED, COMPOSITION, 4.7K ±10%, 1/2W	01121	2
R16	EB3311	RESISTOR, FIXED, COMPOSITION, 330 ohms, ±10%, 1/2W	01121	1
R17	EB3331	RESISTOR, FIXED, COMPOSITION, 33K ±10%, 1/2W	01121	1
R18	EB1041	RESISTOR, FIXED, COMPOSITION, 100K ±10%, 1/2W	01121	1
R19	EB1021	RESISTOR, FIXED, COMPOSITION, 1K ±10%, 1/2W	01121	8
R20 thru R24	EB1031	RESISTOR, FIXED, COMPOSITION, 10K ±10%, 1/2W	01121	25
R25		(SAME AS R19)		
R26	EB2211	RESISTOR, FIXED, COMPOSITION, 220 ohms ±10%, 1/2W	01121	4
R27		(SAME AS R20)		
R28		(SAME AS R20)		
R29		(SAME AS R19)		
R30 thru R33		(SAME AS R20)		
R34		(SAME AS R19)		
R35		(SAME AS R26)		

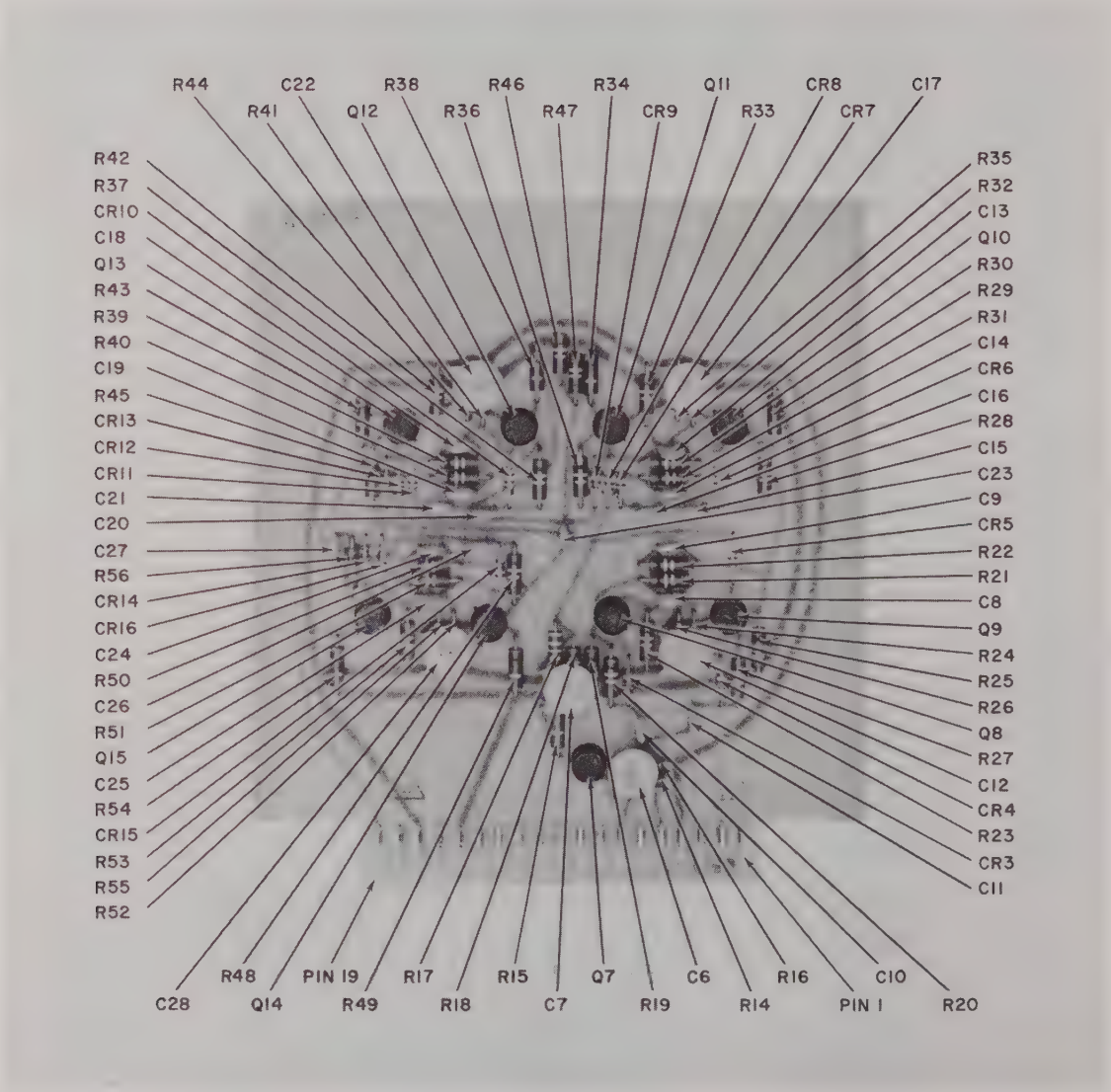


Figure 5-11. Single Decade, Card A13

SINGLE DECADE, CARD A13 (Cont)
(SEE FIGURE 5-11)

Ref. Desig or Index No.	Part No.	Description	Mfr Code	Qty Per Assy
R36		(SAME AS R20)		
R37		(SAME AS R20)		
R38		(SAME AS R19)		
R39 thru R42		(SAME AS R20)		
R43		(SAME AS R19)		
R44		(SAME AS R26)		
R45		(SAME AS R20)		
R46		(SAME AS R20)		
R47	EB2231	RESISTOR, FIXED, COMPOSITION, 22K ±10%, 1/2W	01121	1
R48		(SAME AS R20)		
R49		(SAME AS R19)		
R50 thru R53		(SAME AS R20)		
R54		(SAME AS R19)		
R55		(SAME AS R26)		
R56		(SAME AS R20)		
TB1	620-E-214	PRINTED CIRCUIT BOARD	15356	1
-1	632-A-108	RAIL, PLASTIC	15356	2

MANUFACTURERS CODE LIST

CODE	NAME AND ADDRESS
00656	Aerovox Corp. 740 Belleville Ave. New Bedford, Mass. 02741
01121	Allen-Bradley Co. 1201 South 2nd Street Milwaukee, Wis. 53204
02735	Radio Corp. of America Commercial Receiving Tube and Semiconductor Div. Somerville, N.J.
03508	General Electric Co. Semiconductor Products Dept. Electronics Park Syracuse, N.Y. 13201
04213	Caddell-Burns Mfg. Co., Inc. 40 East 2nd St. Mineola, N.Y.
04713	Motorola Semiconductor Products, Inc. 5005 East McDowell Road Phoenix, Ariz. 85008
05292	International Telephone & Telegraph Corp. Components Div. 100 Kingsland Road Clifton, N.J.
07263	Fairchild Camera and Instrument Corp. Semiconductor Div. 313 Frontage Rd. Mountain View, Calif.
08806	General Electric Co. Miniature Lamp Dept. Nela Park Cleveland, Ohio 44112
09253	Bryant Mfg. Co. 2020 Montcalm Street Indianapolis, Ind.
12954	Dickson Electronics Corp. 302 S. Wells Fargo Ave. Scottsdale, Ariz.
13327	Solitron Devices, Inc. 256 Oak Tree Road Tappen, N.Y. 10983
15356	Transistor Specialties, Inc. 120 Terminal Drive Plainview, N.Y. 11803
18621	Alltronics of California 841 Warrington Street Redwood City, Calif. 94063

MANUFACTURERS CODE LIST (Cont)

CODE	NAME AND ADDRESS
44655	Ohmite Mfg. Co. 3601 Howard St. Skokie, Ill. 60076
56289	Sprague Electric Co. North Adams, Mass.
71450	CTS Corp. 1142 W. Beardsley Ave. Elkhart, Ind.
71590	Centralab Division of Globe-Union, Inc. 932 E. Keefe Ave. Milwaukee, Wisc. 53212
72136	Electro Motive Mfg. Co., The South Park and John Streets Willimantic, Conn. 06226
73899	J F D Electronics Corp. 15th at 62nd St. Brooklyn, N.Y.
75382	Kulka Electric Corp. 633 S. Fulton Ave. Mt. Vernon, N.Y. 10550
75915	Littelfuse, Inc. 800 E. Northwest Hwy. Des Plaines, Ill. 60016
76385	Minor Rubber Co., Inc. 49 Ackerman St. Bloomfield, N.J. 07003
79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
80294	Bourns Laboratories, Inc. Riverside, Calif.
81349	Military Specifications Promulgated by Standardization Div. Directorate of Logistic Services D S A
81640	Control Switch Div. Controls Co. of America Folcroft, Pa.
82142	Jeffers Electronics Div. of Speer Carbon Co. DuBois, Pa.
83781	National Electronics, Inc. 628 North St. Geneva, Ill. 60134
91418	Radio Materials Co. 4242 W. Bryn Mawr Chicago, Ill. 60646
91506	Augat, Inc. 33 Perry Ave. Attleboro, Mass. 02703
91662	Elco Corp. Willow Grove, Pa.
94066	Northern Engineering Co. Hitchcock Ave. Baraboo, Wisc.
95624	Central Research Laboratories, Inc. R F D 2 Red Wing, Minn. 55066
95712	Dage Electric Co., Inc. Hurricane Road Franklin, Ind.
96906	Military Standards Promulgated by Standardization Div. Directorate of Logistic Services D S A
98002	Stauffer Chemical Co. 500 S. Virgil St. Los Angeles, Calif. 90005

SECTION VI

SCHEMATIC DIAGRAMS

The following list details the schematic diagrams in this section with regard to the figure and page numbers.

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6-1	Logic Diagram	6-2
6-2	Channel A and B Amplifier, Card A9	6-3
6-3	Gating Logic, Card A10	6-4
6-4	Single Decade, Card A13	6-5
6-5	Triple Decade, Card A7	6-6
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6-7	Decade Readout, Cards A1 through A4	6-8
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6-9	Decade Readout, Card A6	6-10
6-10	Character and Decimal Point, TB2	6-11
6-11	Oscillator, Card A12	6-12
6-12	Power Supply, Card A11	6-13
6-13	Wiring Diagram	6-14

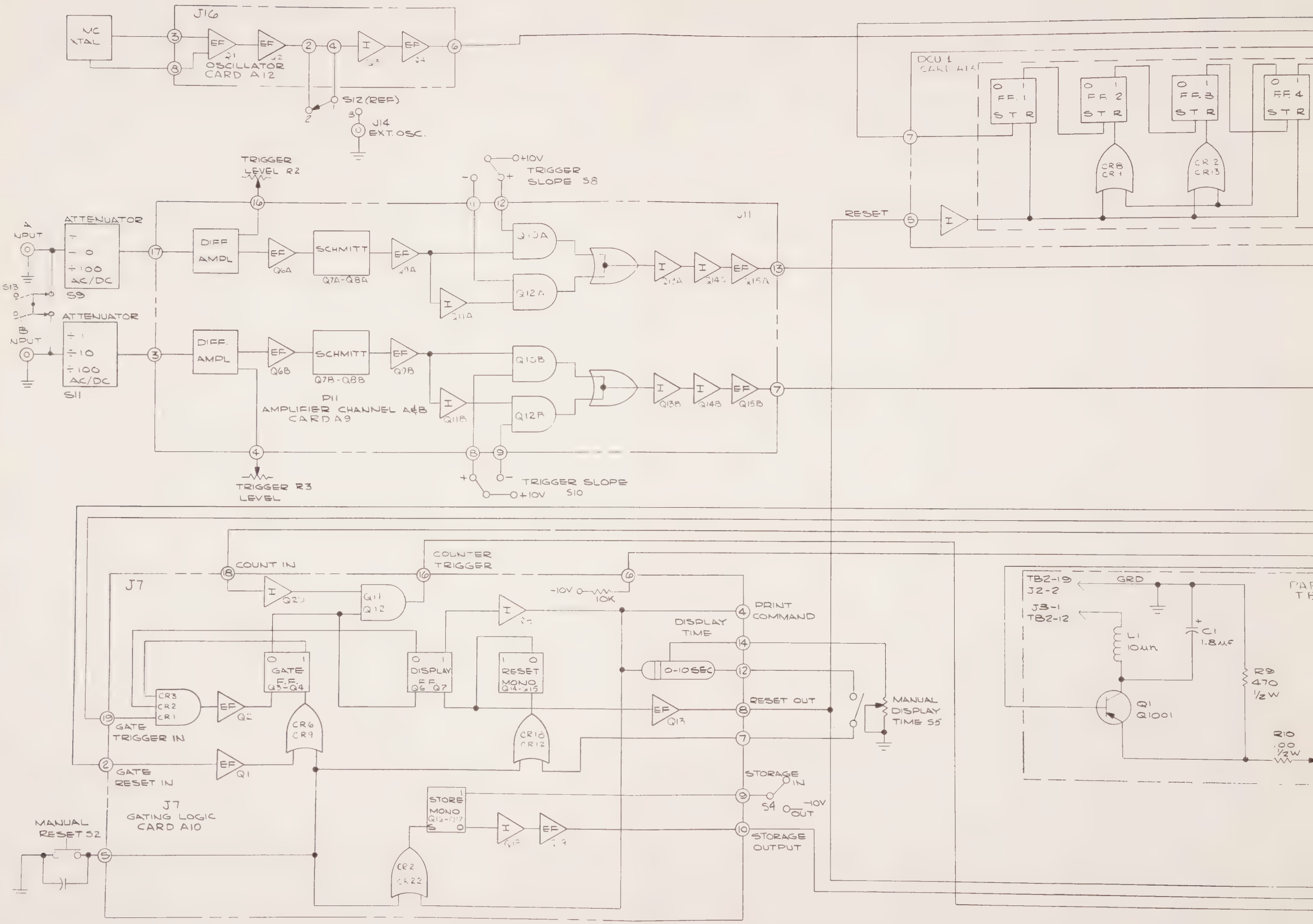


Figure 6-1. Logic Diagram

J10 1Hz

R4 100Ω ¼W RATIO B/AXM FREQ A INTERVAL A-B/ DER A PER AXM TEST

R5 100Ω ¼W COUNT

START

STOP

S6 FUNCTION

A12 MANUAL MANL. 2 S3 .47

MANUAL TIMING S3

B12

C12

D12

E12

F12

MHz KHz Hz μS MS S

DEC PT #1 DEC PT #2 DEC PT #3

S7 TIME BASE

1-10-100KC TRIPLE DECADE CARD A8 J9 DCU 10 DCU 10^1 DCU 10^2

1-10-100 PPS TRIPLE DECADE CARD A9 J8 DCU 10^3 DCU 10^4 DCU 10^5

CHARACTER AND DECIMAL TB2

CR4 CR5 CR6 CR1 CR3 CR2 CER 70A

R3 R4 R5 R1 R2 100K R8 R7 R6 220K

E15 E14 E13 E18 E16 E17 E7 E8 E9 E22 E23 E24 E20 E21 E6 E3 E4

TO TB2-E2 +300V

E1 +300V NE2 E2 +300V NE1

S M C K M

11 6 2 7 5 VC

V6 V5 V4 V3 V2 V1 NE3

MATRIX STORAGE DCU J6 J5 J4 J3 J2 J1

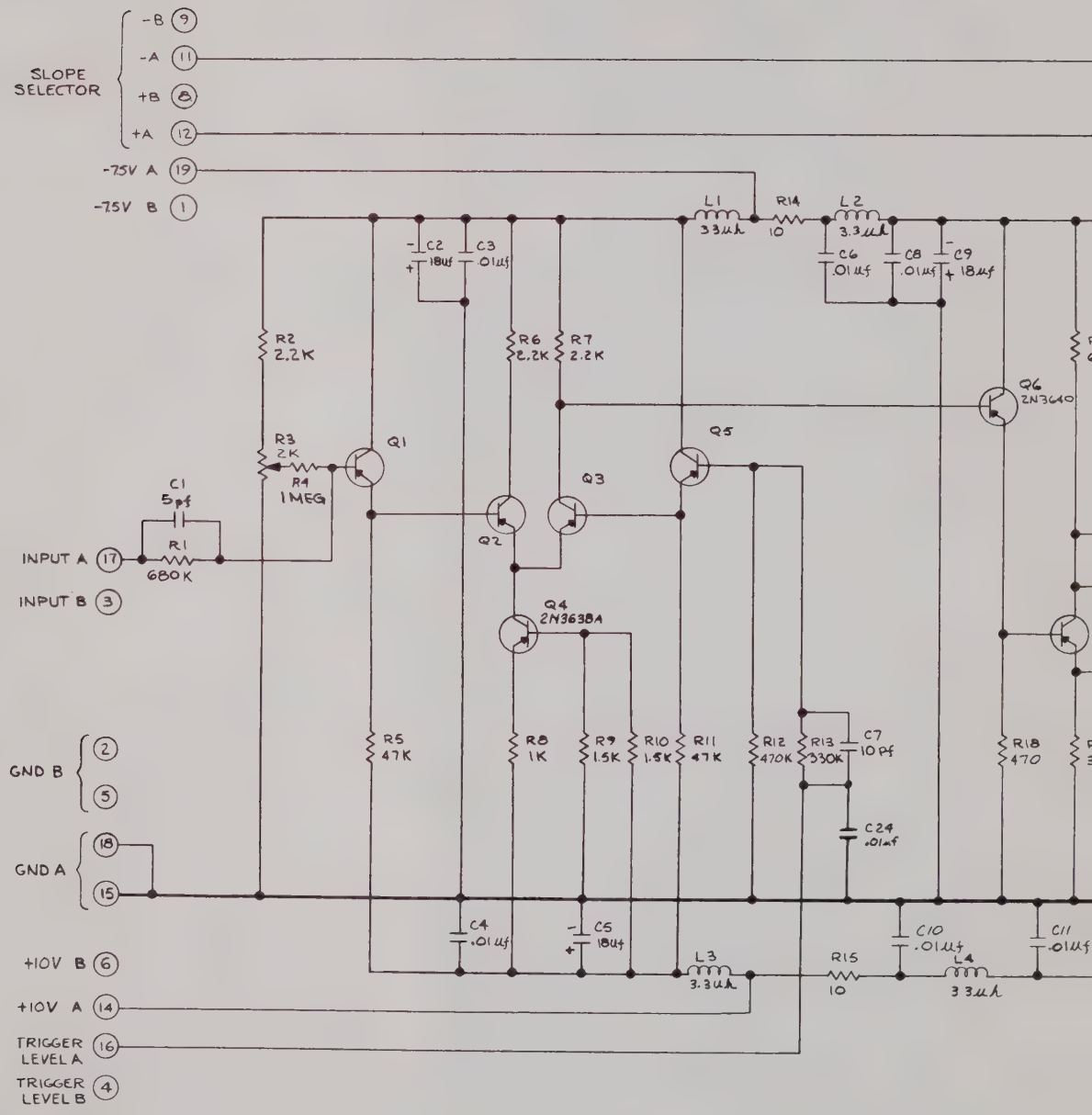
Q1 Q10

FREQ STD J18 TB2-E10

DECADE READOUT #14 CARDS A1-A4

DECADE READOUT #13 CARD A5

DECADE READOUT #12 CARD A6



NOTES

1. Q2 & Q3 ARE MATCHED 2N3640 DC BETA 10%
2. Q1 & Q5 ARE MATCHED 2N3638A YELLOW DOT DC BETA TO 10%
3. ALL RESISTORS ARE ¼ W 10% UNLESS OTHERWISE SPECIFIED.
4. PRINTED CKT. BD NO 644-E-100

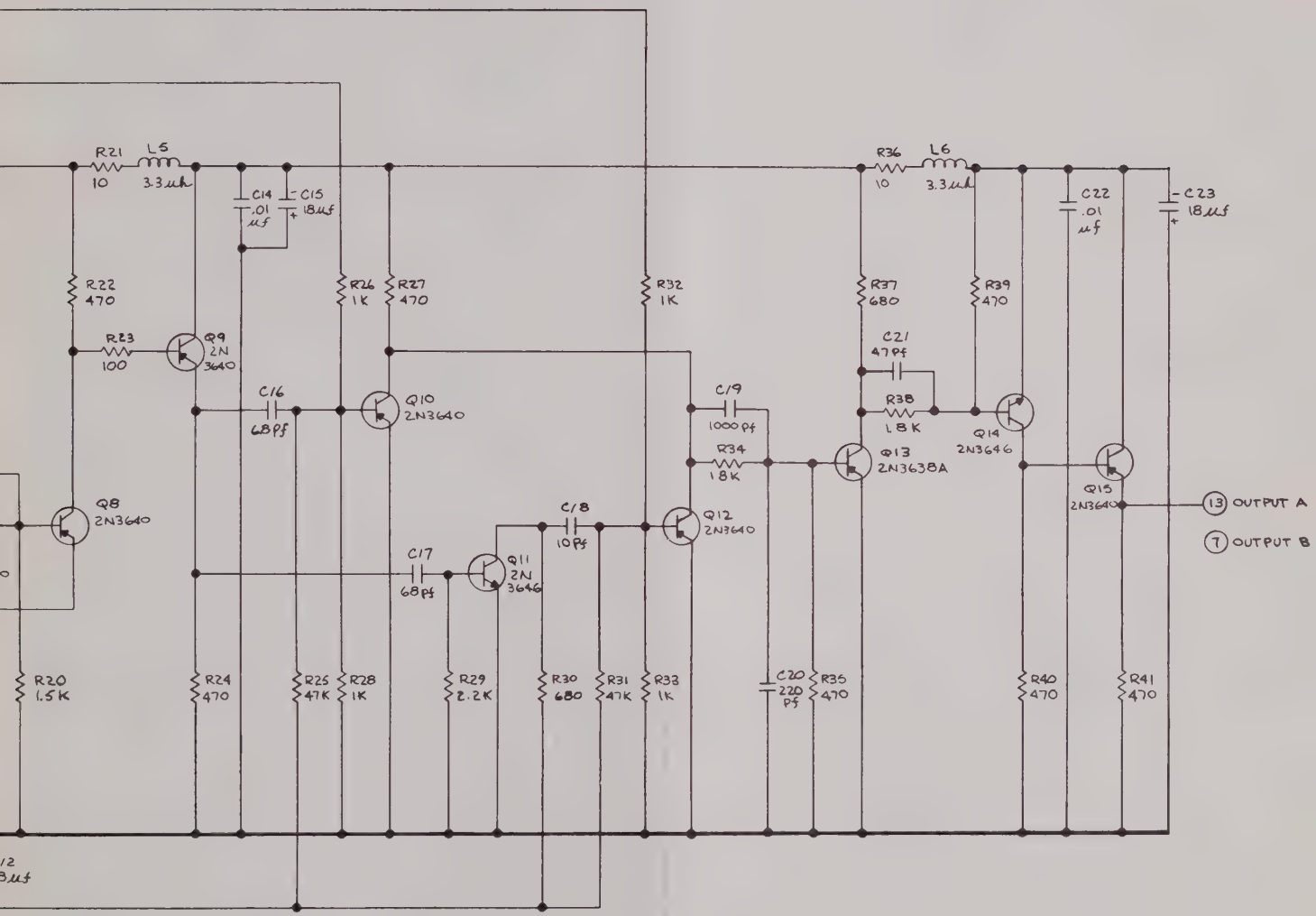
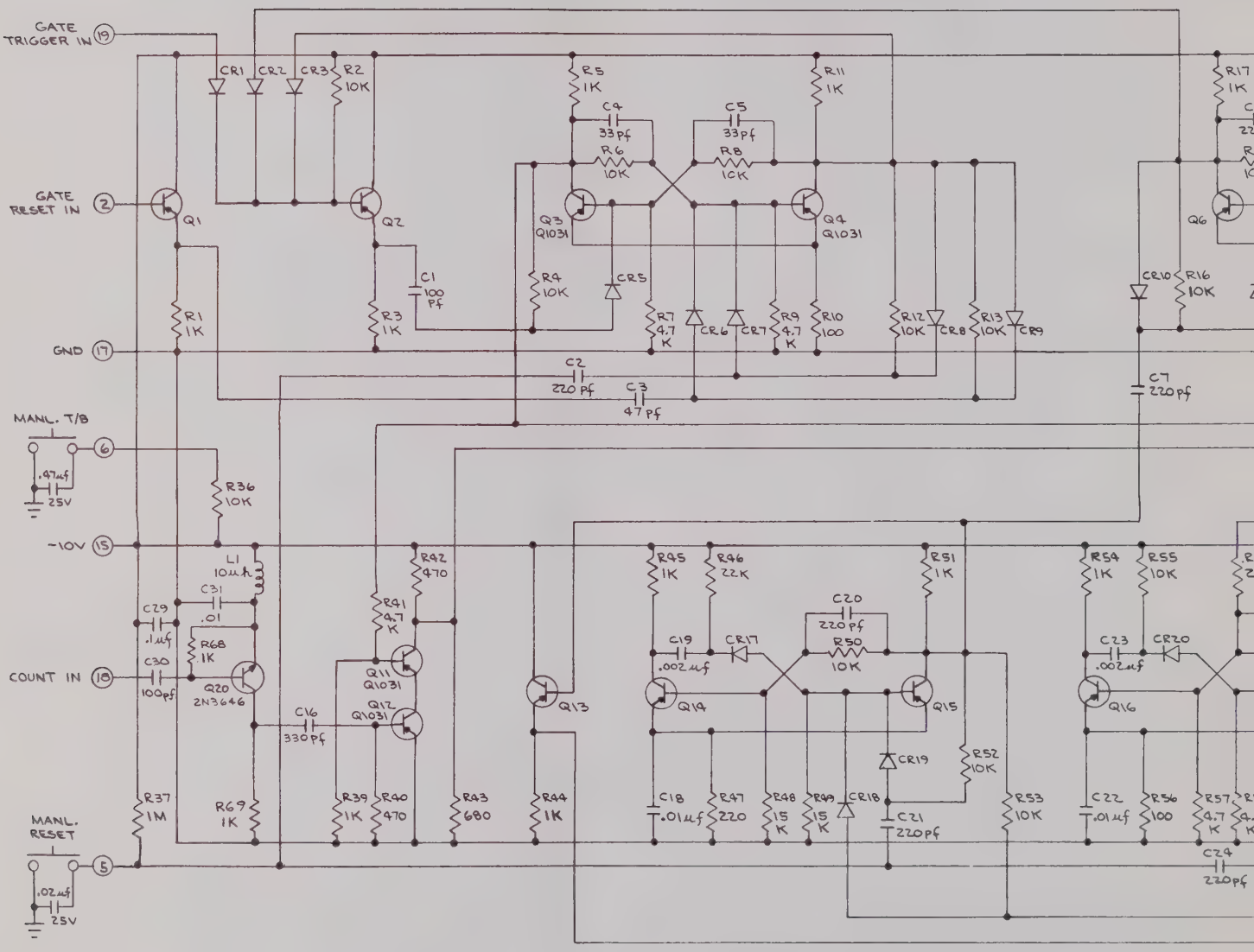
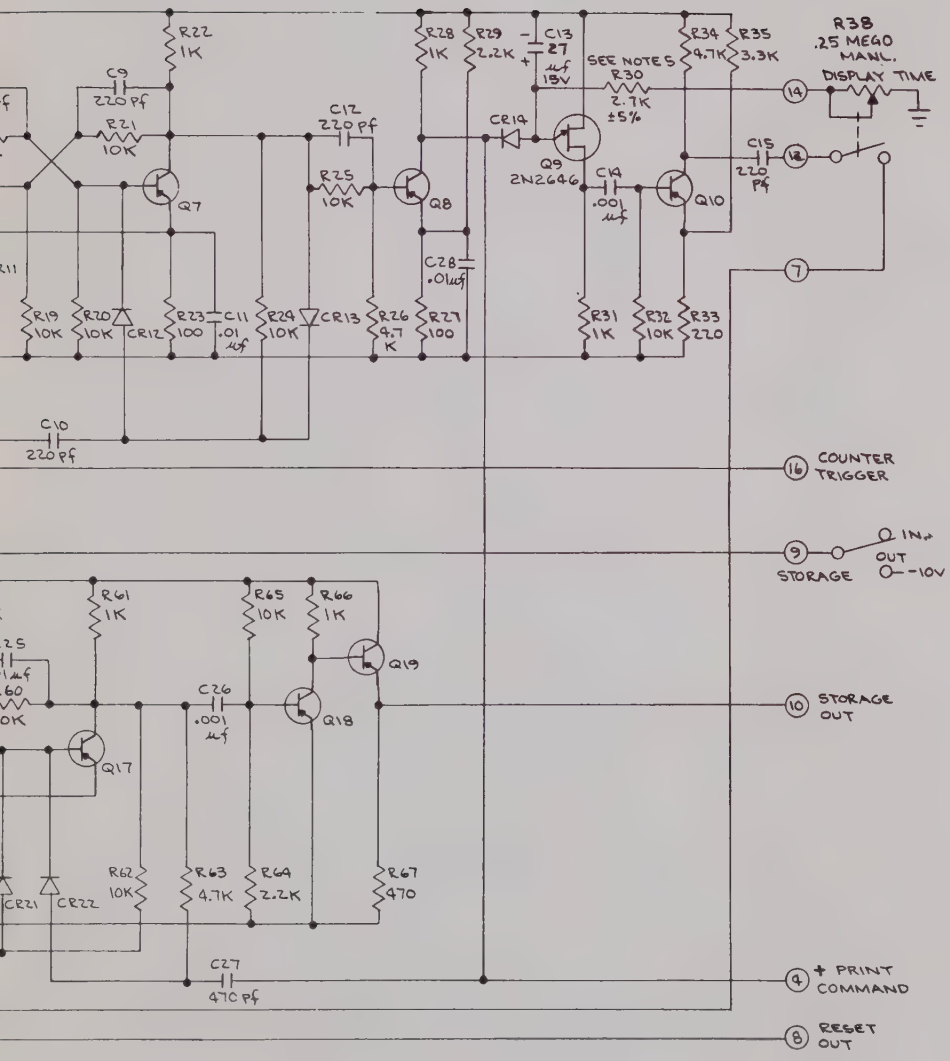


Figure 6-2. Channel A and B Amplifier, Card A9, Schematic Diagram

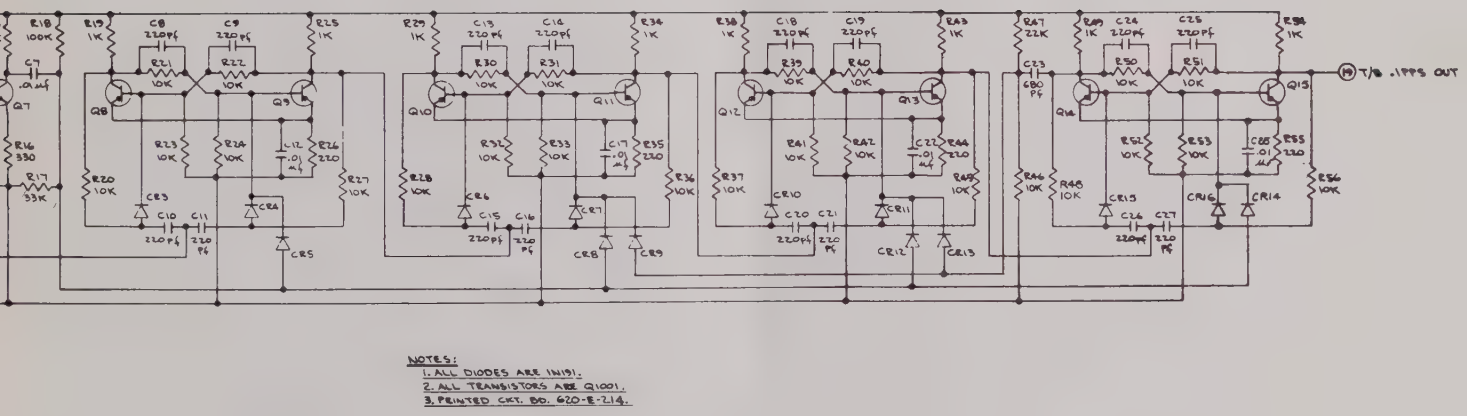


NOTES:
1. ALL DIODES ARE IN191 UNLESS OTHERWISE SPECIFIED.
2. ALL TRANSISTORS ARE Q1001 UNLESS OTHERWISE SPECIFIED.
3. ALL RESISTORS ARE ½W ±10%.
4. PRINTED CKT. BD. 644-E-107.
5. R30 = 4.7K WHEN PRINTER READOUT IS USED.

Figure 6-3. Gating Logic, Card A10, Schematic Diagram

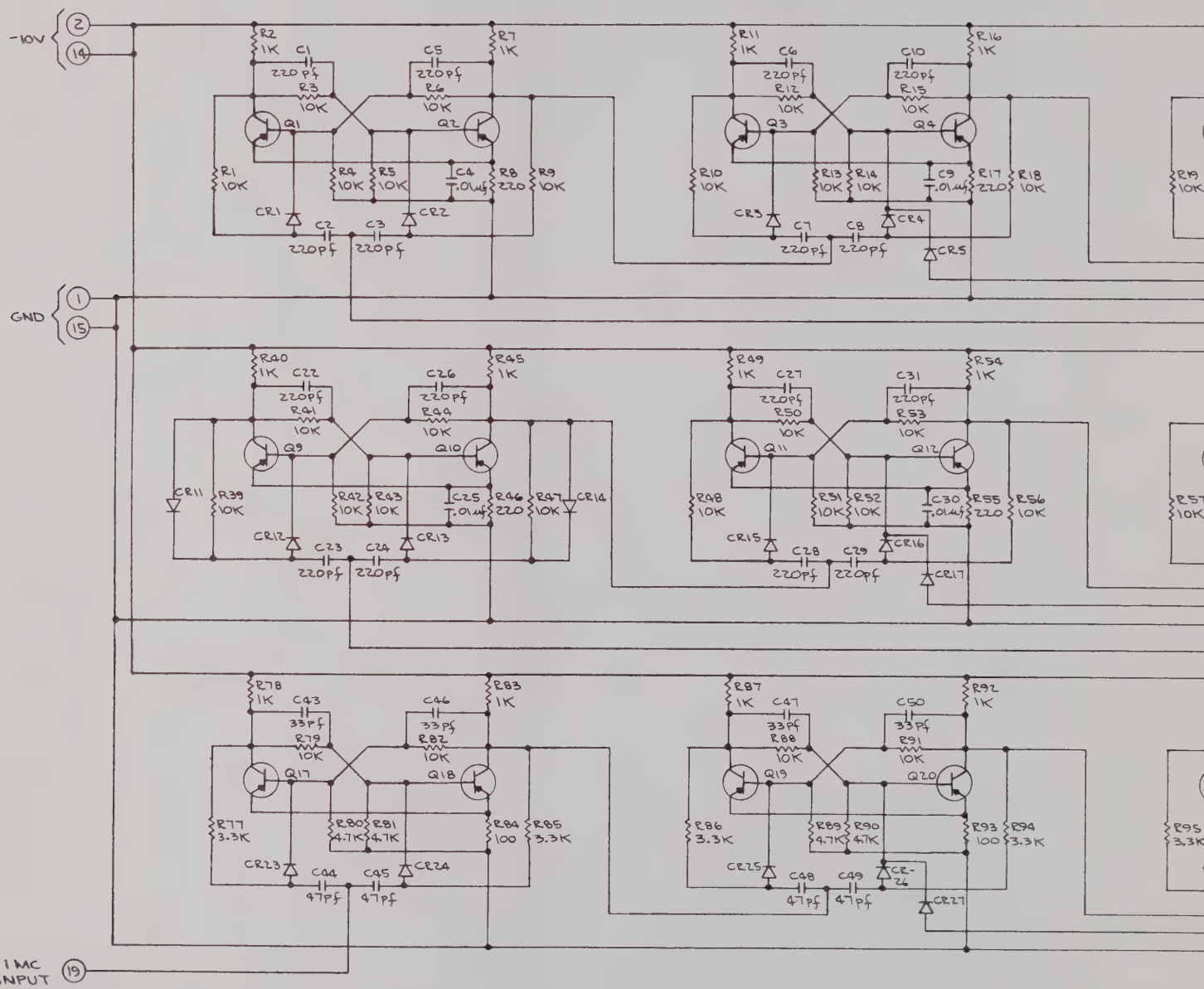

R22 1K
C9 220 pf
R21 10K
Q7
C12 270 pf
R25 10K
Q8
R28 1K
R29 2.2K
C13 27 uf 15V
CR14
Q9 2N2646
SEE NOTE 5
R30 2.7K ±5%
R34 4.7K
R35 3.3K
R38 .25 MEGO MANL. DISPLAY TIME
C15 220 pf
C14 .001 uf
Q10
C28 .01uf
R19 10K
R20 10K
CR12
R23 100
C11 .01 uf
R24 10K
CR13
R26 4.7 K
R27 100
R31 1K
R32 10K
R33 220
C10 220 pf
14
12
7
16 COUNTER TRIGGER
9 STORAGE
IN
OUT
-10V
R61 1K
R65 10K
R66 1K
Q19
C26 .001 uf
Q18
10 STORAGE OUT
Q17
R62 10K
R63 4.7K
R64 2.2K
R67 470
CR21
CR22
C27 470 pf
4 + PRINT COMMAND
8 RESET OUT

-10V
RESET
1. CPB IN
GND



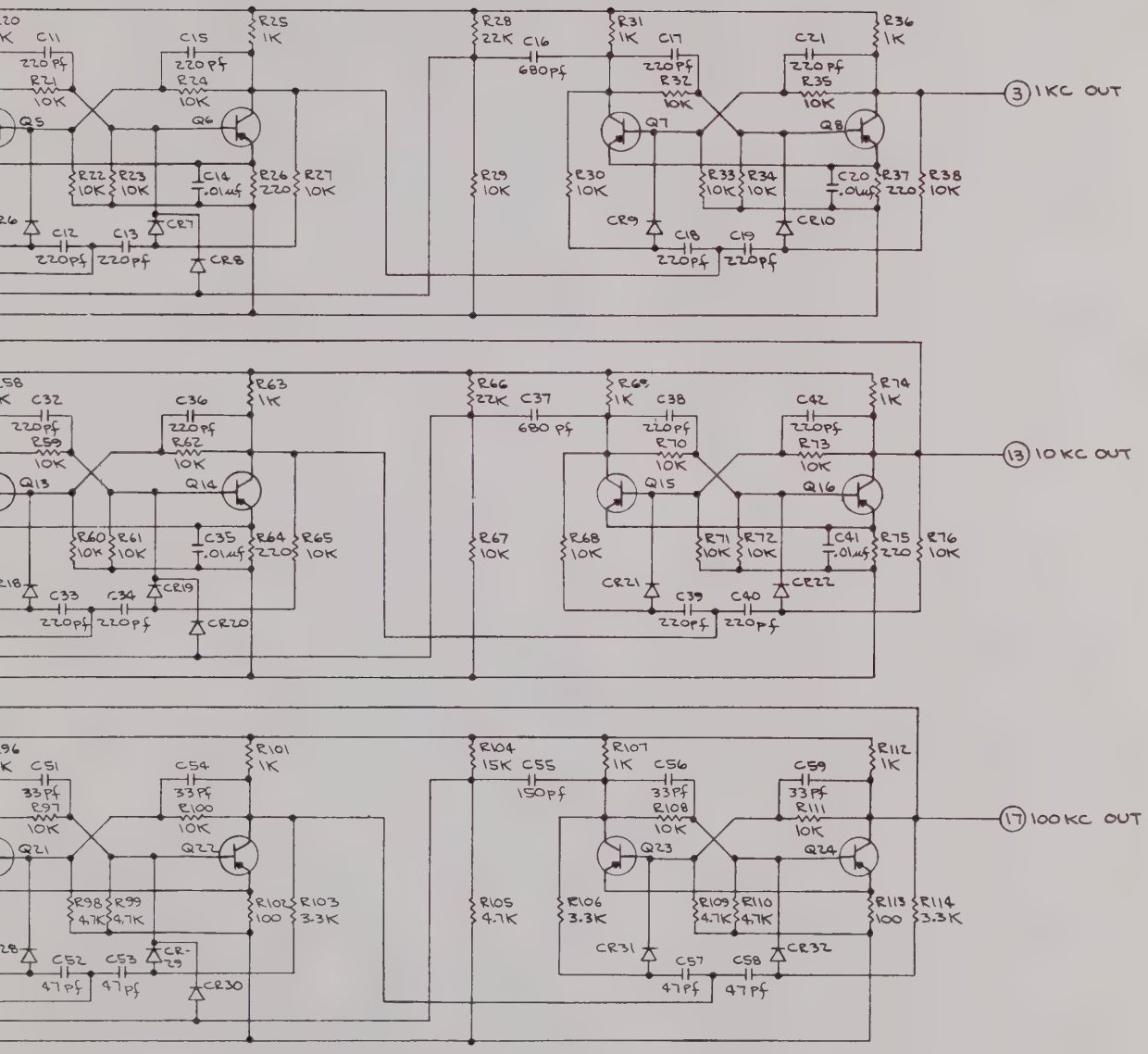
NOTES:
1. ALL DIODES ARE 1N191.
2. ALL TRANSISTORS ARE Q1001.
3. PRINTED CKT. BD. 620-E-214.

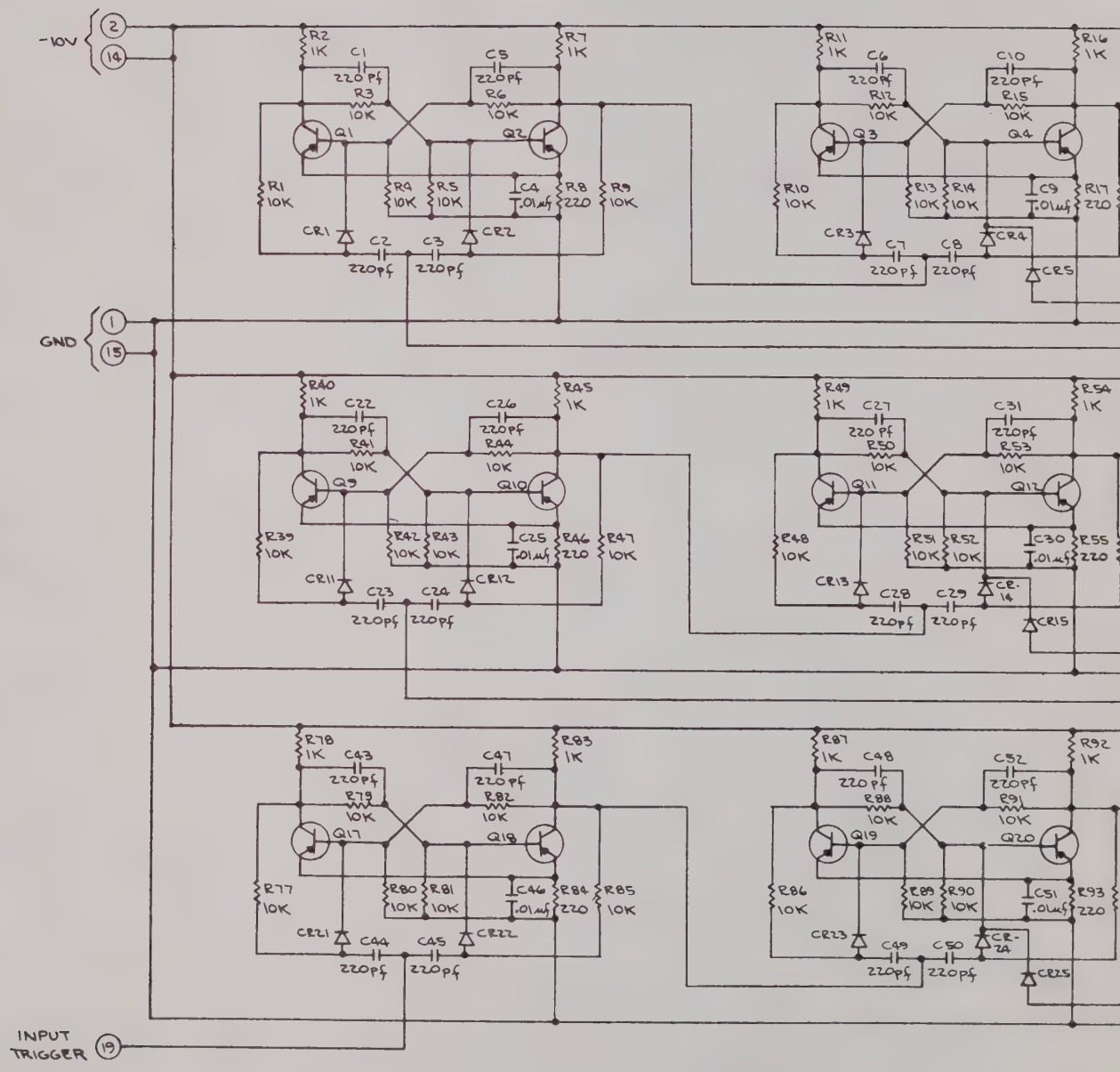
Figure 6-4. Single Decade, Card A13, Schematic Diagram



NOTES:
1. ALL DIODES ARE IN191.
2. Q1 THRU Q16 ARE Q1001.
3. Q17 THRU Q24 ARE Q1031.
4. PRINTED CKT. BD. # 620-D-150.
5. ALL RESISTORS ARE ½ W.

Figure 6-5. Triple Decade, Card A7, Schematic Diagram


C11
220 pf
R21
10K
Q5
C15
220 pf
R24
10K
Q6
R25
1K
R22
10K
R23
10K
C14
.01uf
R26
220
R27
10K
C12
220pf
C13
220pf
CR7
CR8
R28
22K
C16
680pf
R29
10K
R31
1K
C17
220pf
R32
10K
Q7
C21
220 pf
R35
10K
Q8
R36
1K
R30
10K
R33
10K
R34
10K
C20
.01uf
R37
220
R38
10K
CR9
C18
220pf
C19
220pf
CR10
3 1KC OUT
C32
220pf
R59
10K
Q13
C36
220pf
R62
10K
Q14
R63
1K
R60
10K
R61
10K
C35
.01uf
R64
220
R65
10K
C33
220pf
C34
220pf
CR19
CR20
R66
22K
C37
680 pf
R67
10K
R69
1K
C38
220pf
R70
10K
Q15
C42
220pf
R73
10K
Q16
R74
1K
R68
10K
R71
10K
R72
10K
C41
.01uf
R75
220
R76
10K
CR21
C39
220pf
C40
220pf
CR22
13 10KC OUT
C51
33pf
R97
10K
Q21
C54
33pf
R100
10K
Q22
R101
1K
R98
4.7K
R99
4.7K
R102
100
R103
3.3K
C52
47pf
C53
47pf
CR29
CR30
R104
15K
C55
150pf
R105
4.7K
R107
1K
C56
33pf
R108
10K
Q23
C59
33pf
R111
10K
Q24
R112
1K
R106
3.3K
R109
4.7K
R110
4.7K
R113
100
R114
3.3K
CR31
C57
47pf
C58
47pf
CR32
17 100KC OUT



NOTES:

1. ALL DIODES ARE IN191.
2. ALL TRANSISTORS ARE Q1001.
3. PRINTED CKT. NO. 620-D-150.
4. ALL RESISTORS ARE ½W.

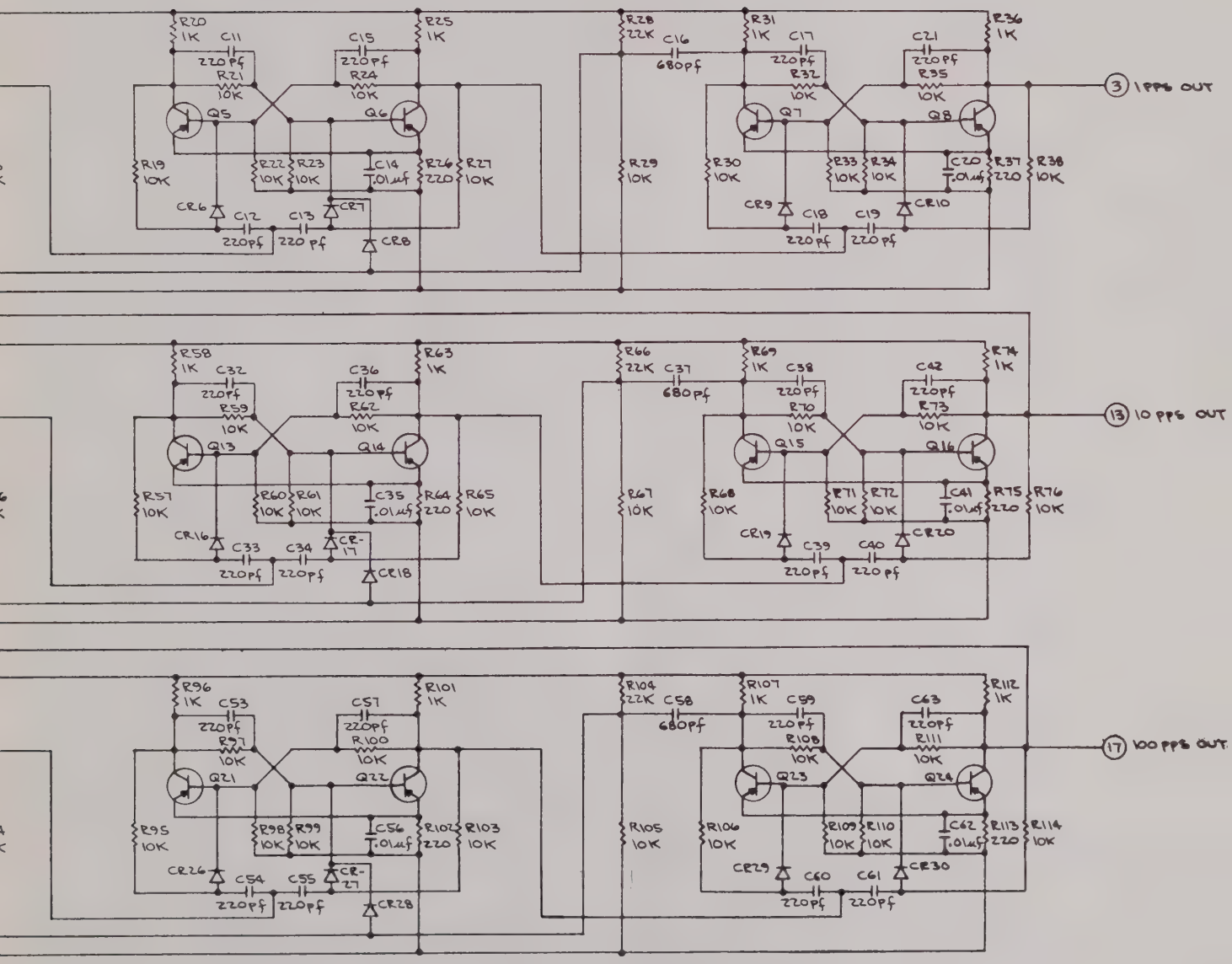


Figure 6-6. Triple Decade, Card A8, Schematic Diagram

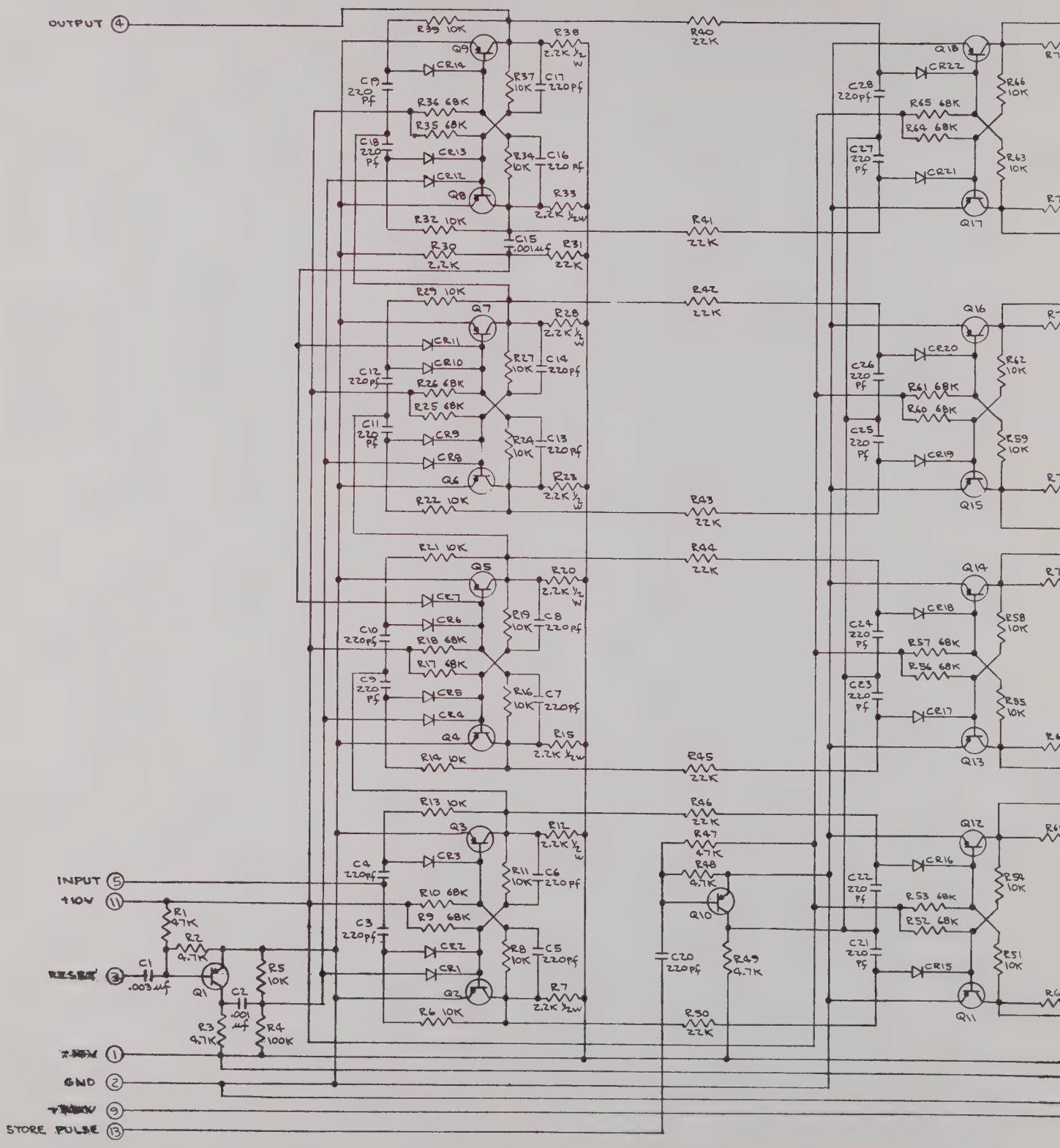
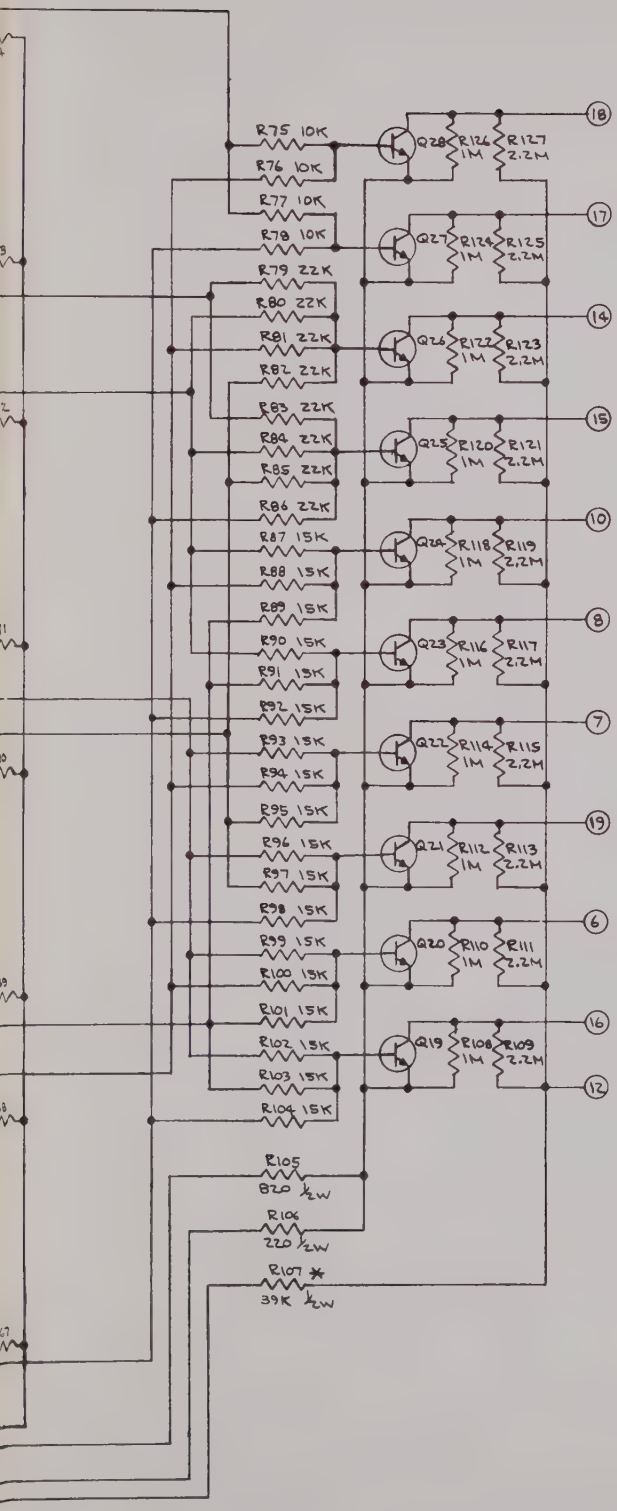
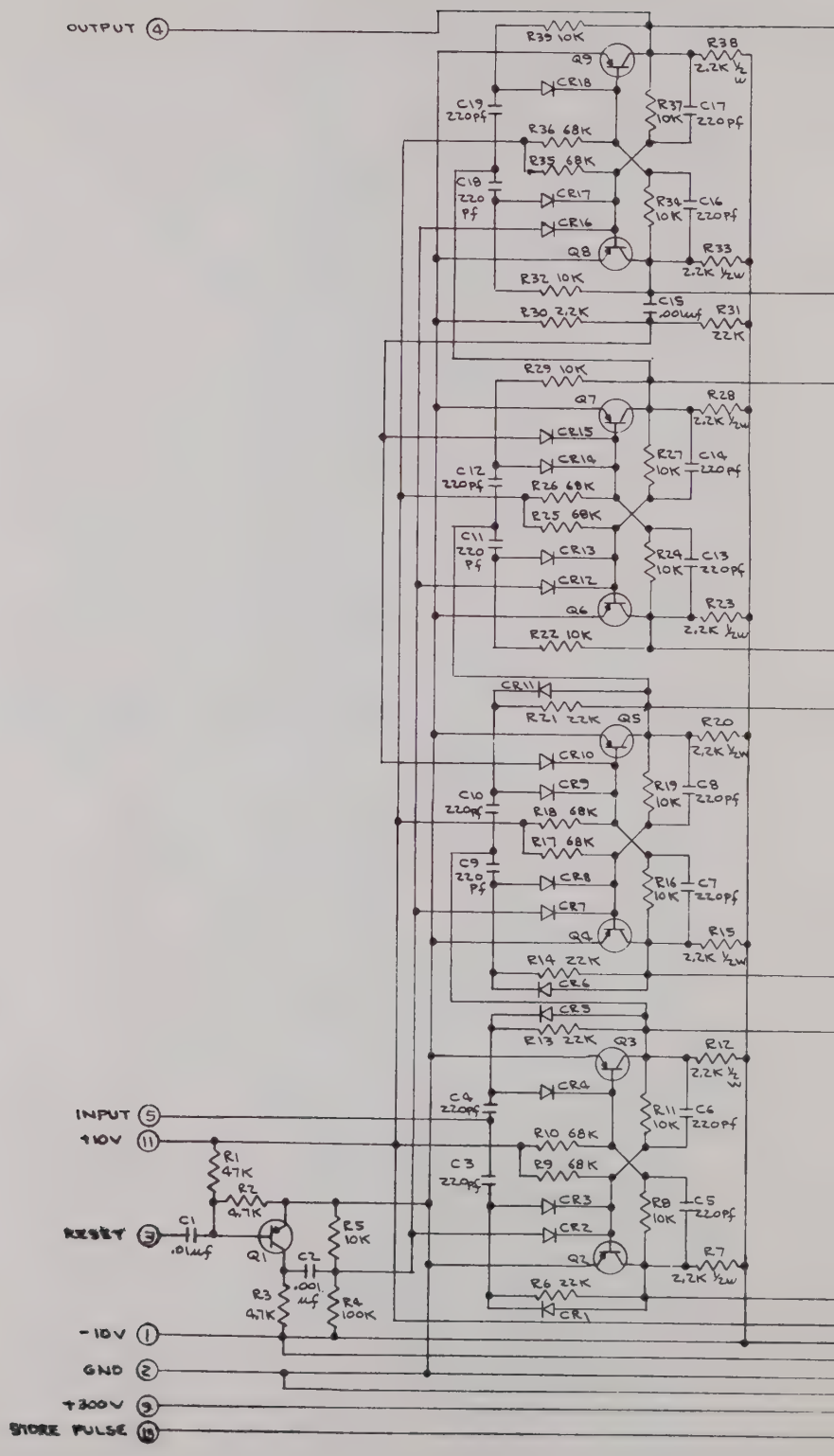


Figure 6-7. Decade Readout, Cards A1 through A4, Schematic Diagram



NOTES:

1. ALL RESISTORS ARE 1/4 W UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE ±10%.
3. ALL DIODES ARE IN191.
4. TRANSISTORS:
   Q1 THRU Q18 ARE 2N404,
   Q19 THRU Q28 ARE Q100Z.
5. R67 THRU R74 ARE 2.2 K
* 6. CHANGE R107 FROM 56K 1/2 W ±10% TO 36K 1/2W ±5% WHEN USING NIXIE TUBE NO. NL840 AND NL842 AND TO 39K 1/2W ±10% WHEN USING NIXIE TUBE NL5961.


OUTPUT 4
INPUT 5
+10V 11
RESET 3
-10V 1
GND 2
+300V 9
STORE PULSE 10
R39 10K
Q9
R38 2.2K ½ w
CR18
C19 220pf
R37 10K
C17 220pf
R36 68K
R35 68K
C18 220 pf
CR17
R34 10K
C16 220pf
CR16
Q8
R33 2.2K ½w
R32 10K
C15 .001uf
R30 2.2K
R31 22K
R29 10K
Q7
R28 2.2K ½w
CR15
CR14
R27 10K
C14 220pf
C12 220pf
R26 68K
R25 68K
C11 220 pf
CR13
R24 10K
C13 220pf
CR12
Q6
R23 2.2K ½w
R22 10K
CR11
R21 22K
Q5
R20 2.2K ½w
CR10
CR9
R19 10K
C8 220pf
C10 220pf
R18 68K
R17 68K
C9 220 pf
CR8
R16 10K
C7 220pf
CR7
Q4
R15 2.2K ½w
R14 22K
CR6
CR5
R13 22K
Q3
R12 2.2K ½ w
CR4
C4 220pf
R11 10K
C6 220pf
R10 68K
R9 68K
C3 220pf
CR3
R8 10K
C5 220pf
CR2
Q2
R7 2.2K ½w
R6 22K
CR1
R1 47K
R2 4.7K
C1 .01uf
Q1
R5 10K
C2 .001 uf
R3 4.7K
R4 100K

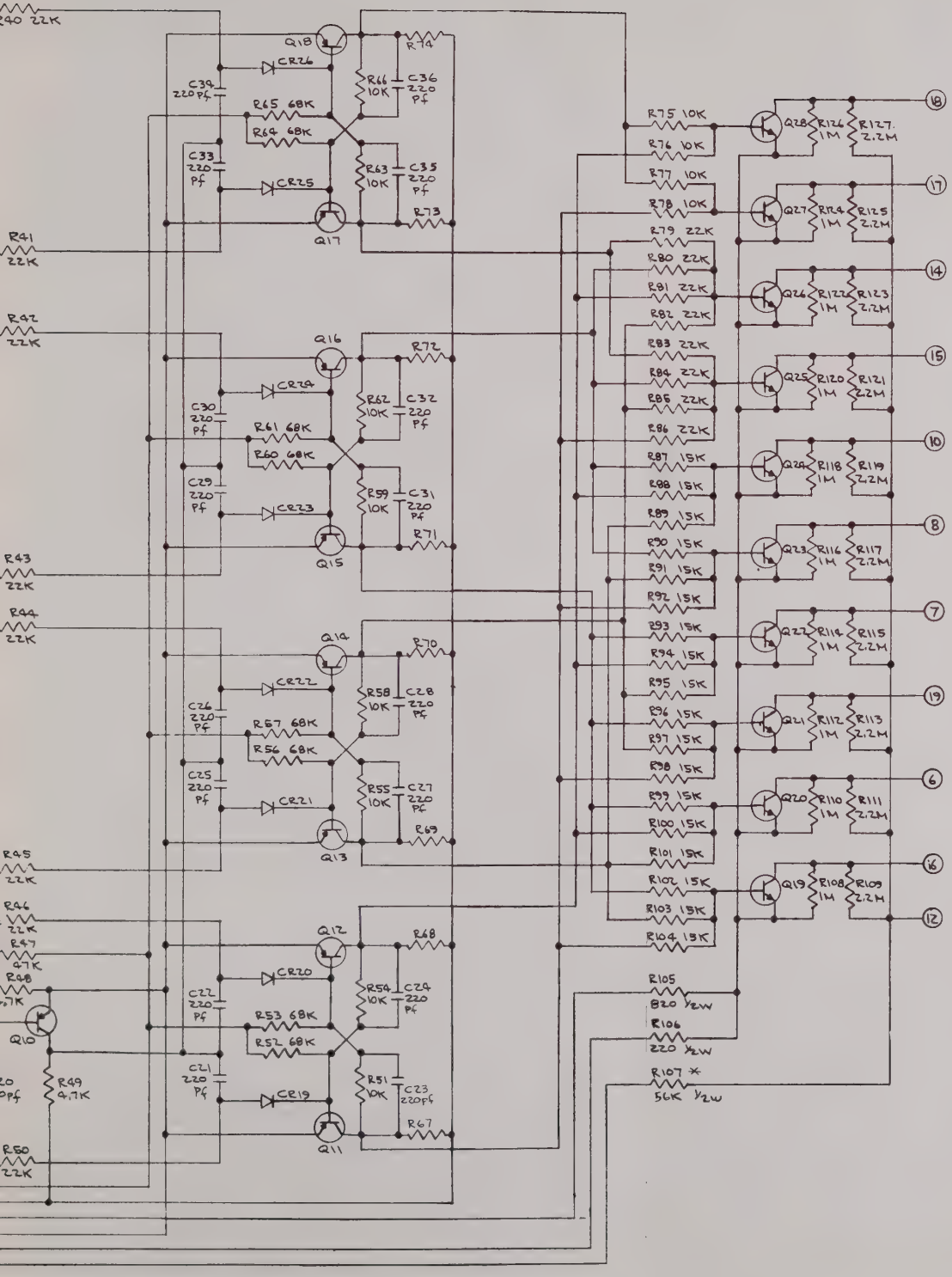


Figure 6-8. Decade Readout, Card A5, Schematic Diagram

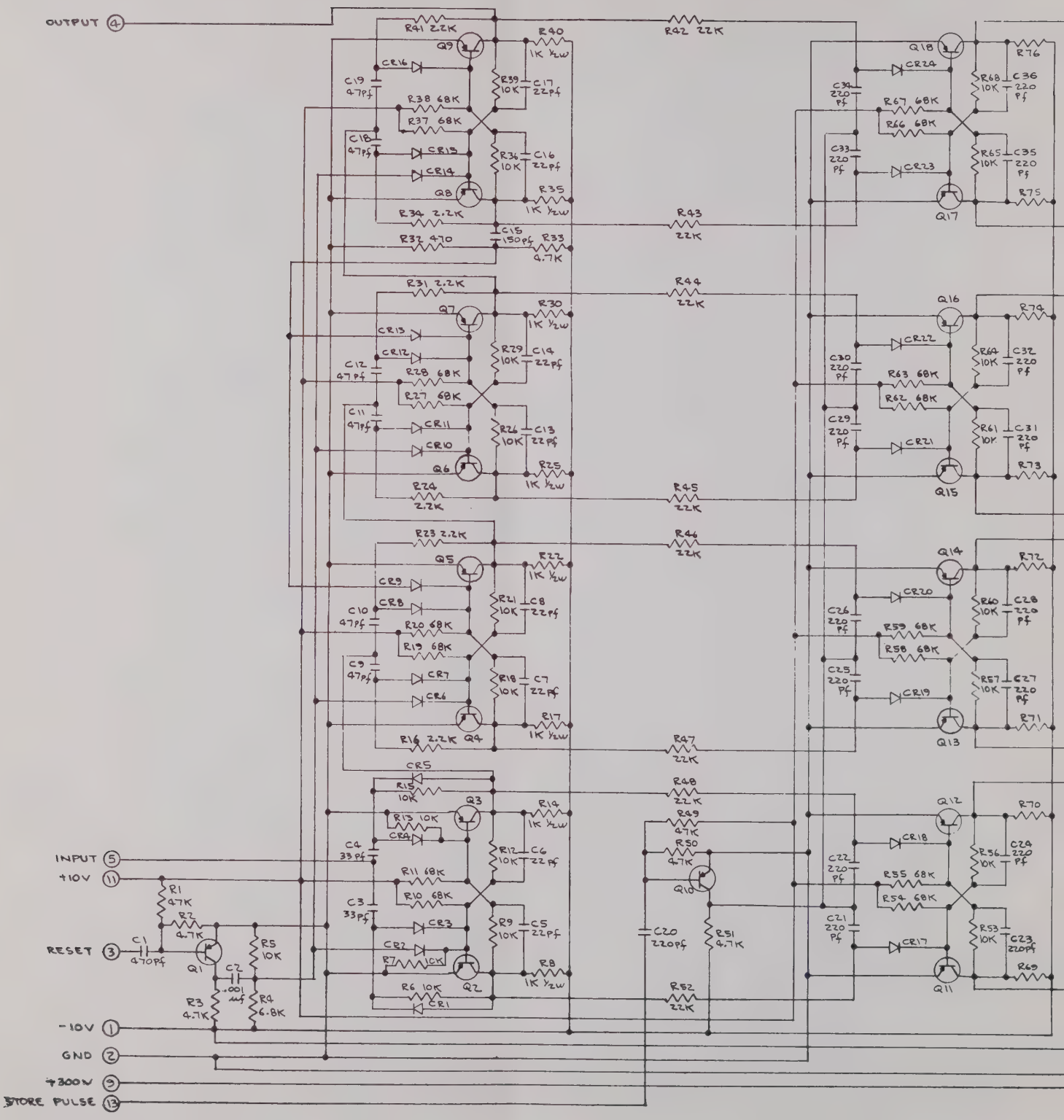
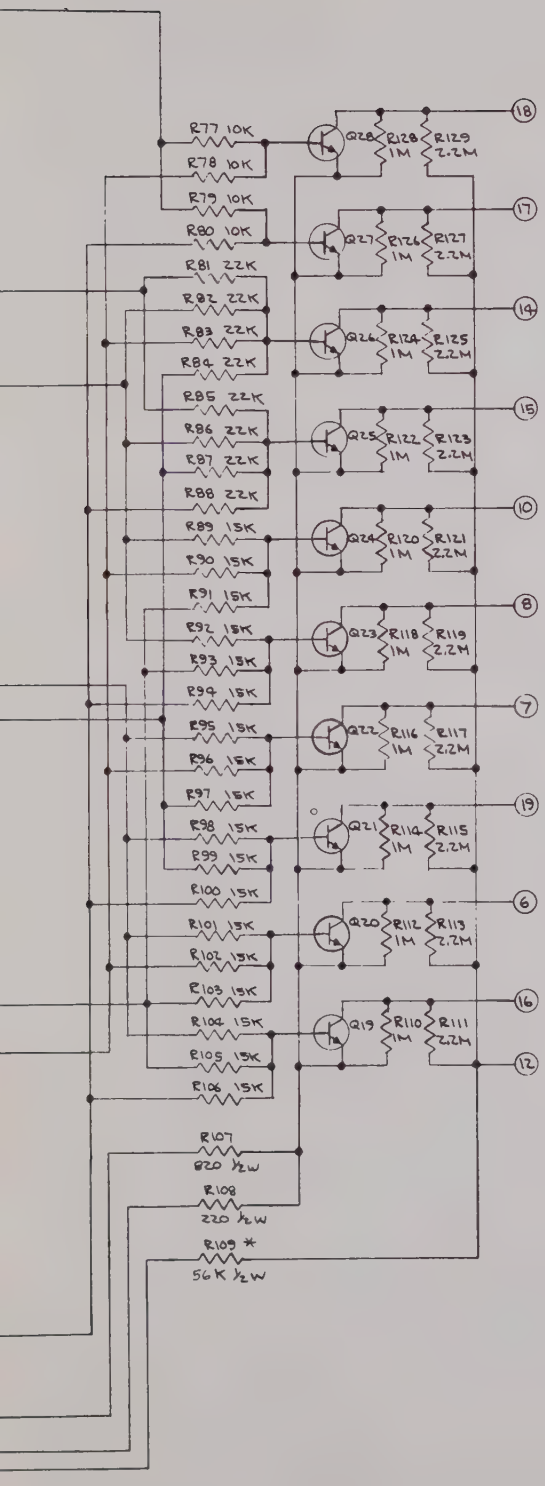


Figure 6-9. Decade Readout, Card A6, Schematic Diagram



NOTES:

1. ALL RESISTORS ARE 1/4W UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE ±10%.
3. DIODES:
   CR1 THRU CR16 ARE CGD 915
   CR17 THRU CR28 ARE 1N191
4. TRANSISTORS:
   Q1, Q10 THRU Q18 ARE 2N409.
   Q2 THRU Q9 ARE Q1031.
   Q19 THRU Q28 ARE Q1002.
5. R69 THRU R76 ARE 2.2K.

* 8. CHANGE R109 FROM 56K 1/2W ±10% TO 36K 1/2W ± 5% WHEN USING NIXIE TUBE NO. NL840 AND NL842 AND TO 39K 1/2W ±10% WHEN USING NIXIE TUBE NL5961.

DEC. P

DEC. P

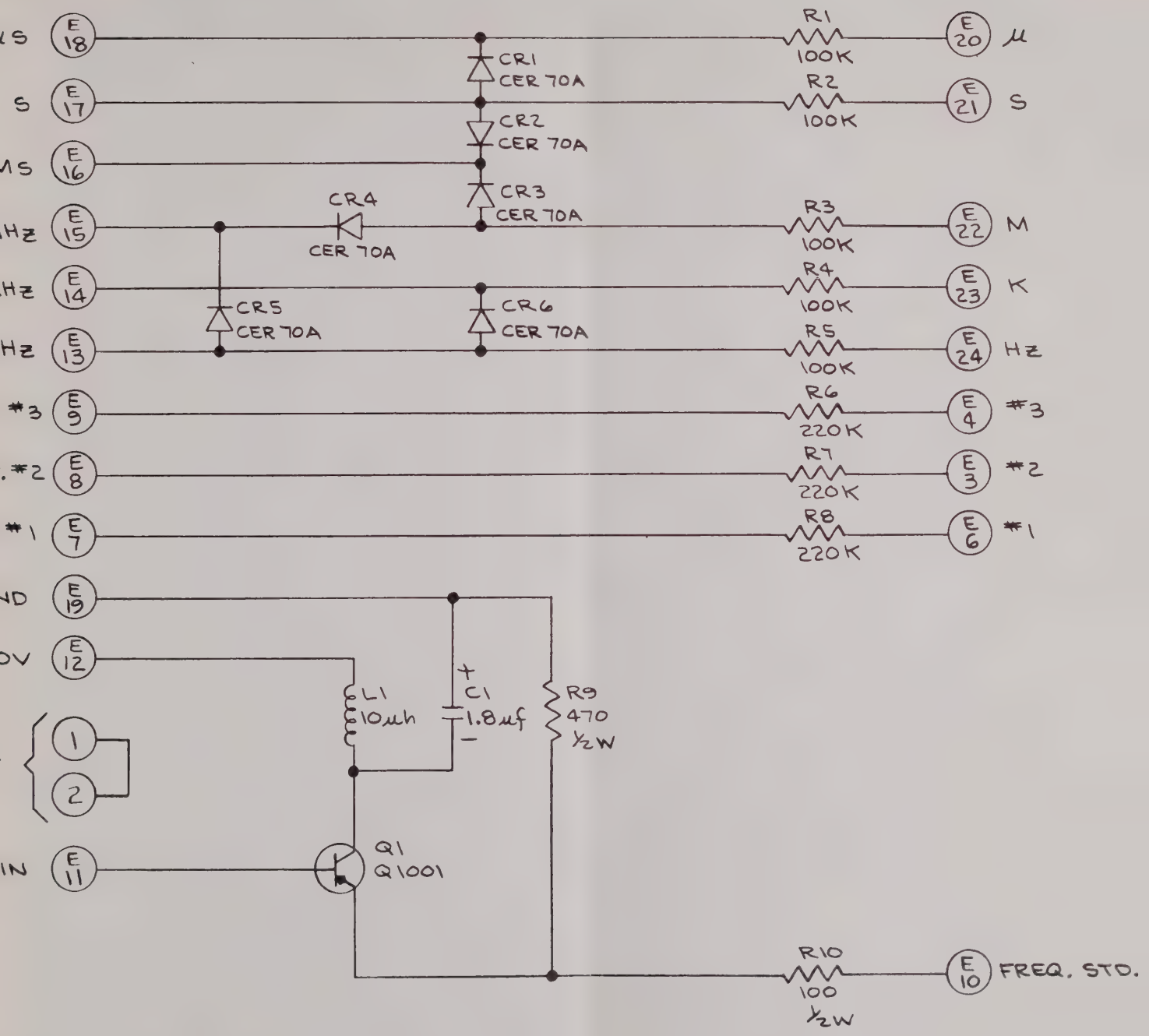
DEC. P

G

+300

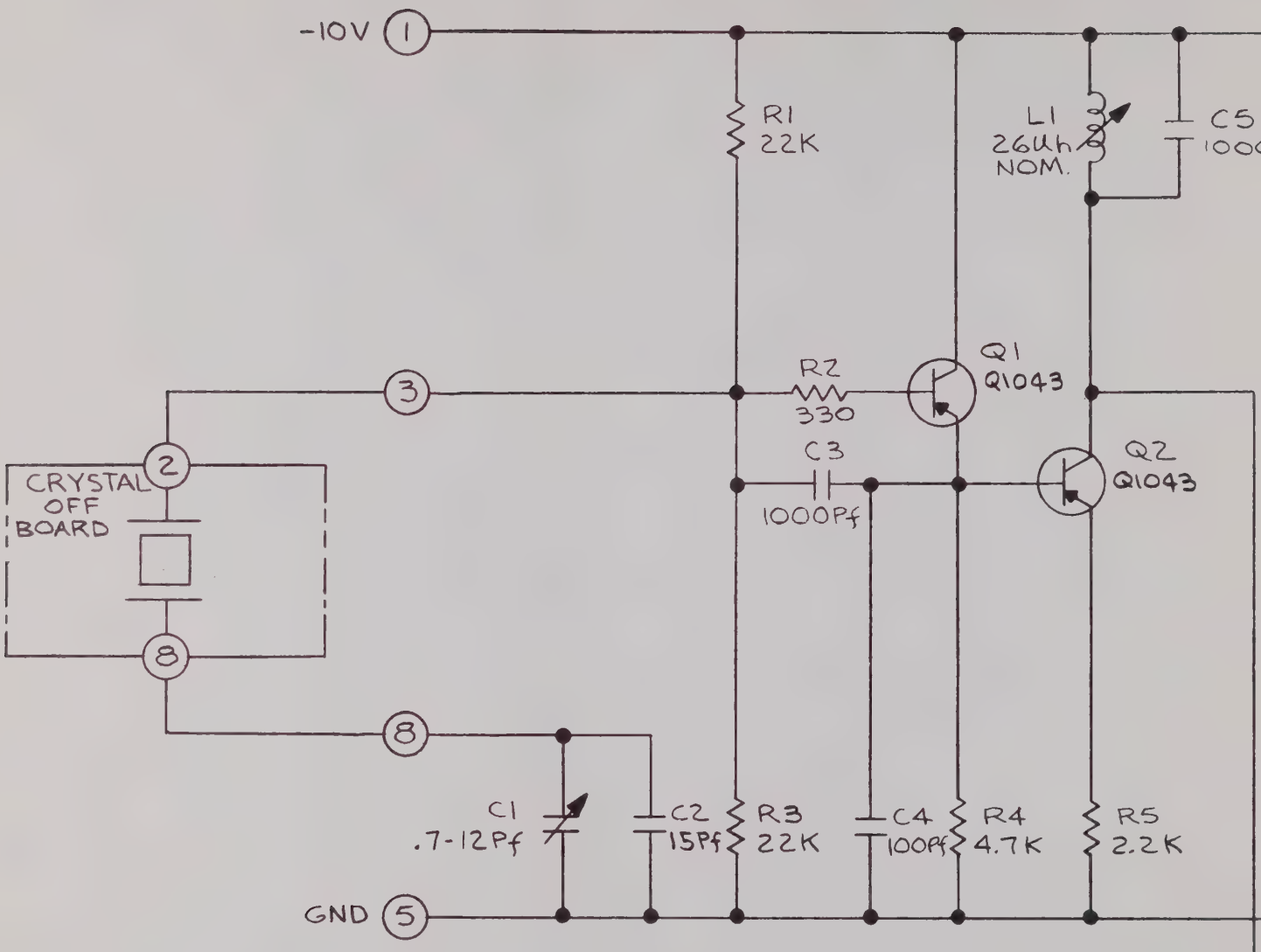
T/B

NOTES:
1. ALL
2. PR



RESISTORS ARE ¼W ±10% UNLESS OTHERWISE SPECIFIED.
INTED CKT. BD. #644-C-135

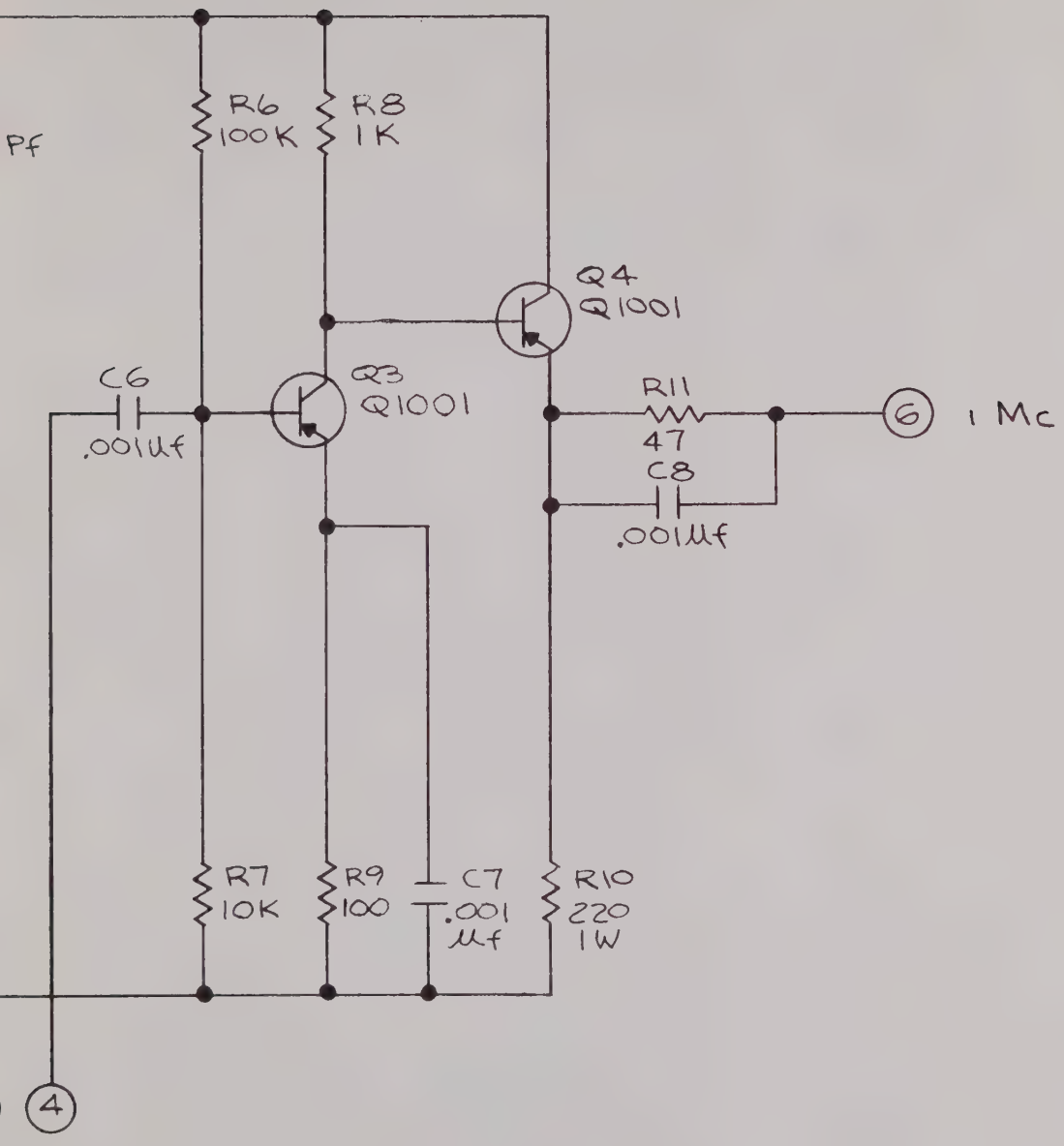
Figure 6-10. Character and Decimal Point, TB2, Schematic Diagram

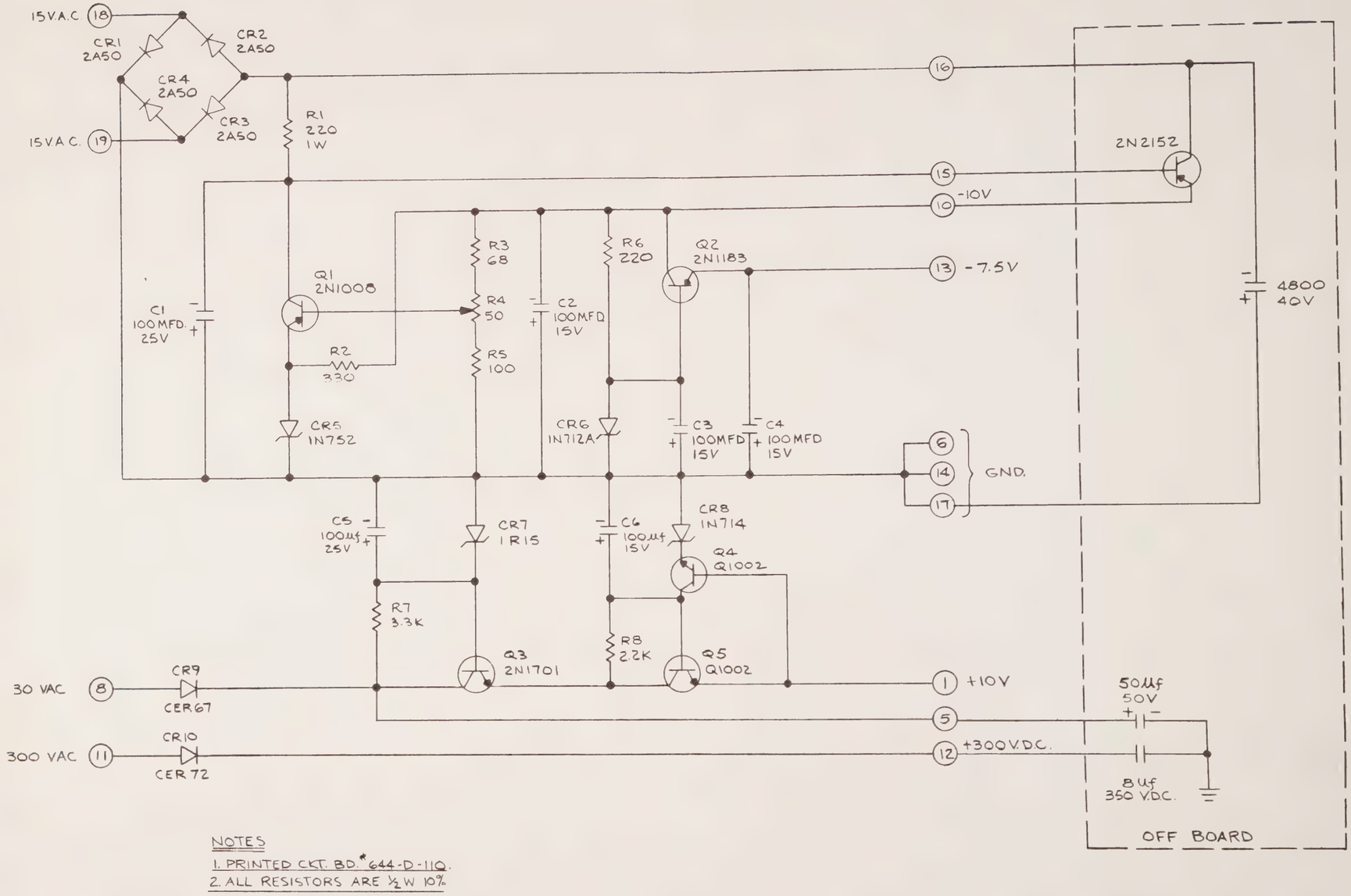


NOTES:

1. ALL RESISTORS ARE ½W 10% UNLESS OTHERWISE SPECIFIED.
2. PRINTED CKT. BD. 644-D-134.

Figure 6-11. Oscillator, Card A12, Schematic Diagram


Pf
R6
100K
R8
1K
Q4
Q1001
C6
.001Mf
Q3
Q1001
R11
47
C8
.001Mf
6
1 Mc
R7
10K
R9
100
C7
.001
Mf
R10
220
1W
4



NOTES
1. PRINTED CKT. BD. #644-D-110.
2. ALL RESISTORS ARE ½W 10%

Figure 6-12. Power Supply, Card A11, Schematic Diagram

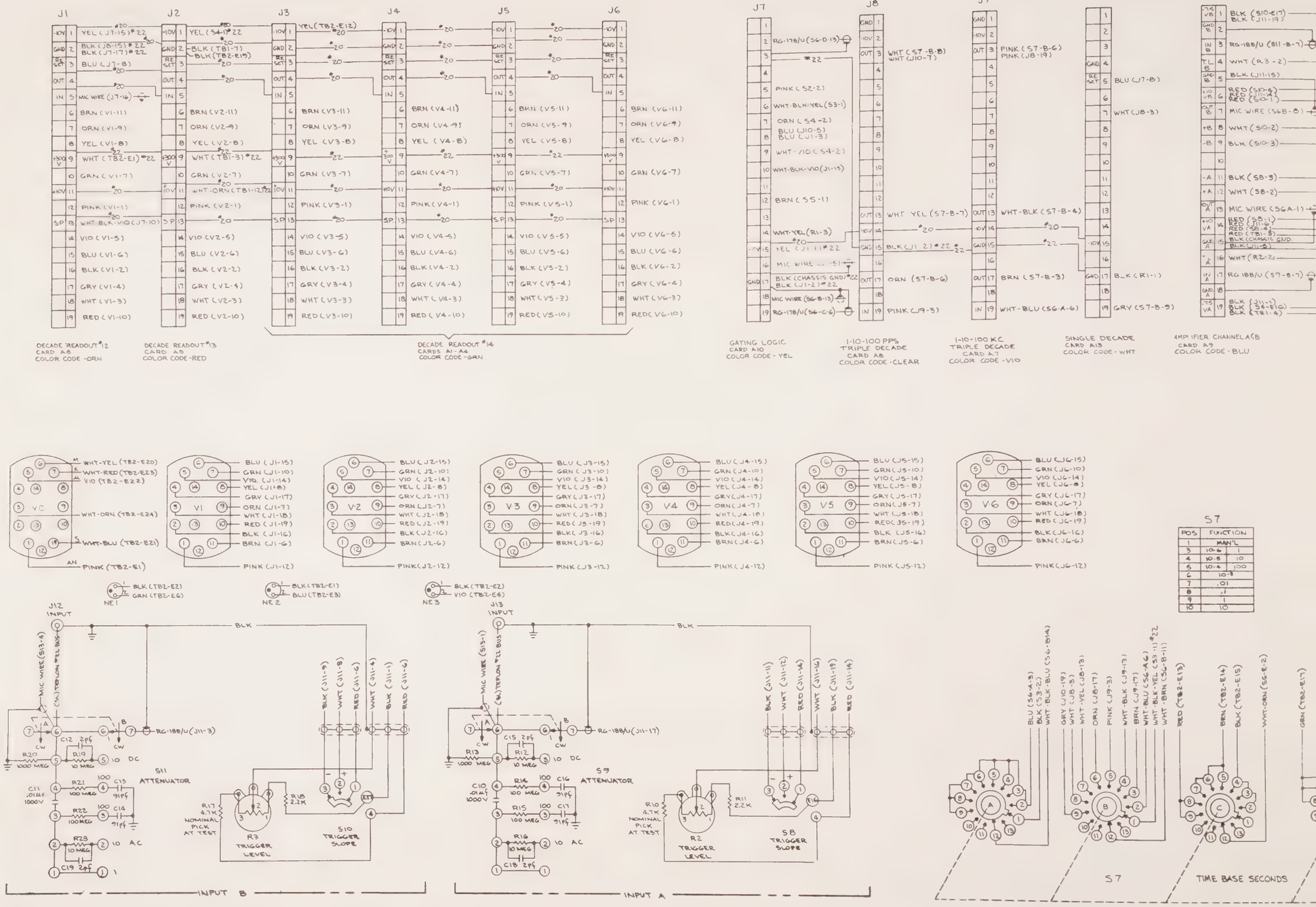
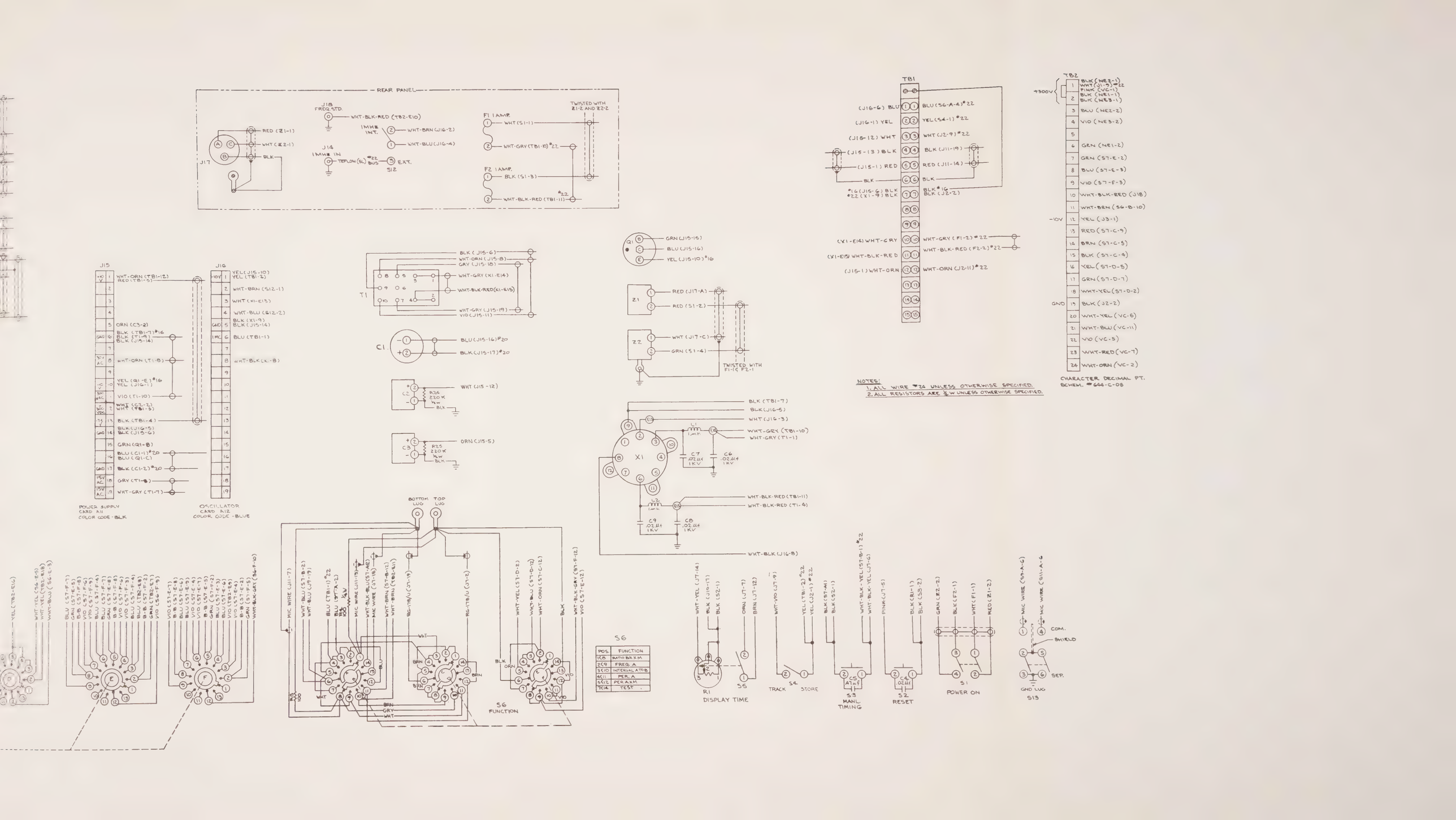


Figure 6-13. Wiring Diagram


REAR PANEL
J17
RED (Z1-1)
WHT (Z2-1)
BLK
J18
FREQ STD.
WHT-BLK-RED (TB2-E10)
1MHz INT.
WHT-BRN (J16-2)
WHT-BLU (J16-4)
J14
1MHz IN
TEFLON (SL)
#22 BUS
EXT.
S12
F1 1 AMP.
WHT (S1-1)
WHT-GRY (TB1-10) #22
F2 1 AMP.
BLK (S1-3)
WHT-BLK-RED (TB1-11)
#22
TWISTED WITH Z1-2 AND Z2-2
TB1
(J16-6) BLU
(J16-1) YEL
(J18-12) WHT
(J15-13) BLK
(J15-1) RED
BLK
#16 (J15-5) BLK
#22 (X1-9) BLK
BLU (S6-A-4) #22
YEL (S4-1) #22
WHT (J2-9) #22
BLK (J11-19)
RED (J11-14)
BLK
BLK #16
BLK (J2-2)
(X1-E14) WHT-GRY
(X1-E15) WHT-BLK-RED
(J15-1) WHT-ORN
WHT-GRY (F1-2) #22
WHT-BLK-RED (F2-2) #22
WHT-ORN (J2-11) #22
TB2
+300V
-10V
GND
BLK (NE3-J)
WHT (J1-9) #22
PINK (VC-1)
BLK (NE1-1)
BLK (NE3-1)
BLU (NE2-2)
VIO (NE3-2)
GRN (NE1-2)
GRN (S7-E-2)
BLU (S7-E-3)
VIO (S7-F-3)
WHT-BLK-RED (J18)
WHT-BRN (S6-B-10)
YEL (J3-1)
RED (S7-C-9)
BRN (S7-C-5)
BLK (S7-C-4)
YEL (S7-D-5)
GRN (S7-D-7)
WHT-YEL (S7-D-2)
BLK (J2-2)
WHT-YEL (VC-6)
WHT-BLU (VC-11)
VIO (VC-5)
WHT-RED (VC-7)
WHT-ORN (VC-2)
CHARACTER DECIMAL PT.
BCHEM. # 644-C-08
NOTES:
1. ALL WIRE #24 UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE ½W UNLESS OTHERWISE SPECIFIED.
J15
J16
WHT-ORN (TB1-12)
RED (TB1-5)
ORN (C3-2)
BLK (TB1-7) #16
BLK (T1-9)
BLK (J15-14)
WHT-ORN (T1-8)
YEL (Q1-E) #16
YEL (J16-1)
VIO (T1-10)
WHT (C2-2)
WHT (TB1-3)
BLK (TB1-4)
BLK (J16-5)
BLK (J15-2)
GRN (Q1-B)
BLU (C1-1) #20
BLU (Q1-C)
BLK (C1-2) #20
GRY (T1-6)
WHT-GRY (T1-7)
YEL (J15-10)
YEL (TB1-2)
WHT-BRN (S12-1)
WHT (X1-E13)
WHT-BLU (C6-2)
BLK (X1-9)
BLK (J15-14)
BLU (TB1-1)
WHT-BLK (X1-B)
POWER SUPPLY CARD A11 COLOR CODE - BLK
OSCILLATOR CARD A12 COLOR CODE - BLUE
T1
BLK (J15-6)
WHT-ORN (J15-8)
GRY (J15-18)
WHT-GRY (X1-E14)
WHT-BLK-RED (X1-E15)
WHT-GRY (J15-19)
VIO (J15-11)
C1
BLU (J15-16) #20
BLK (J15-17) #20
C2
R24 220K ¼W
WHT (J15-12)
C3
R25 220K ¼W
ORN (J15-5)
Q1
GRN (J15-15)
BLU (J15-16)
YEL (J15-10) #16
Z1
Z2
RED (J17-A)
RED (S1-2)
WHT (J17-C)
GRN (S1-4)
TWISTED WITH F1-1 & F2-1
X1
BLK (TB1-7)
BLK (J16-5)
WHT (J16-3)
WHT-GRY (TB1-10)
WHT-GRY (T1-1)
L1 1mH
C7 .02μf 1KV
C6 .02μf 1KV
L2 1mH
C9 .02μf 1KV
C8 .02μf 1KV
WHT-BLK-RED (TB1-11)
WHT-BLK-RED (T1-4)
WHT-BLK (J16-8)
BOTTOM LUG
TOP LUG
MIC WIRE (J11-7)
WHT-BLU (S7-B-2)
WHT-BLU (J9-19)
BLU (TB1-11) #22
BLU (J17-A-2)
#24
MIC WIRE (J11-13)
WHT-BLK-BLU (S7-A-2)
MIC WIRE (J1-18)
WHT-BRN (S7-B-12)
WHT-BRN (TB2-E11)
RG-178/U (J1-19)
RG-178/U (J1-2)
WHT-YEL (S1-D-2)
WHT-BLU (S7-D-12)
WHT-ORN (S7-C-12)
BLK
WHT-BLK-GRY (S7-F-12)
VIO (S7-C-11)
S6 FUNCTION
S6
POS. FUNCTION
1C8 RATIO B/A X M
2C9 FREQ. A
3C10 INTERVAL A TO B
4C11 PER. A
5C12 PER A X M
6C14 TEST
WHT-YEL (J7-14)
BLK (J10-17)
BLK (S2-1)
ORN (J7-7)
BRN (J7-12)
WHT-VIO (J7-9)
YEL (TB1-2) #22
YEL (J12-1) #22
BLK (S7-A1)
BLK (S2-1)
WHT-BLK-YEL (S7-B-13) #22
WHT-BLK-YEL (J7-6)
PINK (J7-5)
BLK (R1-1)
BLK (S3-2)
GRN (E2-2)
BLK (F2-1)
WHT (F1-1)
RED (Z1-2)
R1 DISPLAY TIME
S6
S4 TRACK STORE
C5 .47μf
S3 MANL TIMING
C4 .02μf
S2 RESET
S1 POWER ON
MIC WIRE (S13-A-6)
MIC WIRE (S11-A-6)
COM.
SHIELD
SEP.
GND LUG
S13

NAVSHIPS 0969-244-6010 USER ACTIVITY COMMENT SHEET Vol. No.

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